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ART. XVIII.—*Contributions to the Chemical and Geological History of Bitumens, and of Pyroschists or Bituminous Shales;*[1] by T. STERRY HUNT, M.A., F.R.S.; of the Geological Survey of Canada.[2]

THE economic importance which petroleum has lately assumed gives a new interest to the chemical and geological history of this and of various related substances. It is proposed in the following pages to bring together some facts and theoretical considerations bearing upon the nature, origin and distribution of bitumens, together with a few remarks on the rocks commonly called bituminous shales. Under the general name of bitumen, as is well known, are included both the liquid forms, petroleum and naphtha, and the solid varieties known as asphalt or mineral pitch. The related substances guayaquillite and berengelite, and the substance known as idrialine, seem from the modes of their occurrence to have a similar origin to asphalt, and thus to be distinct from fossil resins. The characters of fusibility and solubility, in liquids like benzole and sulphuret of carbon, serve to distinguish the solid bitumens from coal and some other matters

[1] Communicated to this Journal by the Author, Dec. 31, 1862.

[2] Some of the facts and deductions given in this paper have already appeared in an article by me, entitled *Notes on the History of Petroleum*, which appeared in the *Canadian Naturalist* for July, 1861, and has since been reprinted in the *Chemical News*, and in the Report of the Smithsonian Institution for 1862. I had, for some time previously, maintained that the source of the petroleum of the west was not, as was generally thought, to be found in the Devonian pyroschists, but in the underlying fossiliferous limestones, and had shown the relation of the oil springs to anticlinals.—See a Report of my lecture before the Board of Arts, in the *Montreal Gazette* of March 1, 1861.

about to be noticed. It is to be remarked that the chemical composition of these bodies varies considerably; the earlier analyses of petroleum and naphtha give a composition which approaches C_nH_n; but the later investigations of De la Rue and Muller, on the products distilled from the petroleum of Rangoon, and those of Uelsmann on that from Sehnde, show a slight excess of hydrogen, the various hydrocarbons having, for the most part, the formula C_nH_{n+2}. The first formula C_nH_n may however be adopted, as expressing approximatively the composition of the liquid bitumens. The different analyses of asphalt show a diminished quantity of hydrogen, and small quantities of oxygen. Thus the elastic bitumen from Derbyshire gave to Johnston results which may be represented by $C_{24}H_{22}O_{0\cdot3}$;[1] of two varieties of asphalt analysed by Ebelmann, the one from Bastennes gave $C_{24}H_{16}O_{0\cdot7}$, while that from near Naples may be represented by $C_{24}H_{14\cdot6}O_2$, while an asphalt from Mexico gave to Regnault $C_{24}H_{17}O_2$. The analyses of Johnston show that guayaquillite and berengelite do not differ greatly from these, in the proportions of carbon and hydrogen. Passing from the asphalts to idrialine, the results of whose analysis are represented by $C_{24}H_6$, we have a hydrocarbon with a minimum of hydrogen. It is well in this place to compare the above results with the formula $C_{25}H_{15\cdot9}O_{1\cdot6}$, which is deduced from Wetherell's analysis of the so-called albertite or Albert coal. A "lignite passing into mineral resin" gave to Regnault, $C_{24}H_{15}O_{3\cdot3}$, and five analyses of bituminous coal by the same chemist yield from $C_{24}H_8O_{0\cdot9}$ to $C_{24}H_{10}O_{3\cdot3}$, while the mean composition deduced by Johnston, from several analyses of coal, was $C_{24}H_9$, with from O_2 to O_4. From these results it will be seen that some asphalts approach bituminous coals in composition. That of Naples, which is completely fusible at 140° C., contains less hydrogen and more oxygen than the albertite, while the idrialine is near in composition to certain bituminous coals, which are thus almost isomeric with some fusible bitumens; so that it is easy to conceive the same organic matters giving rise either to coal or to asphalt, even without losing their structure. Such appears to be the case in the Tertiary strata of Trinidad and Venezuela, the bitumen of which from Mr. Wall's researches

[1] In these formulas, which have been calculated for twenty-four equivalents of carbon, to compare with cellulose, $C_{24}H_{20}O_{20}$, I have designed to represent simply the results of analysis, without attempting to fix the constitution of the matters in question. In the notation employed, H=1, C=6, and O=8. As it is not generally used in this Journal, I have not thought necessary to adopt, in this paper, the double equivalent of the latter elements, now employed by so many chemists. I may however call attention to the fact, that I was, I believe, the first to propose such a change, when, in 1853, I asserted that the even co-efficients of oxygen, sulphur and carbon in ordinary formulas seem to furnish a conclusive reason for doubling their equivalents, or for dividing those of hydrogen, chlorine, nitrogen and the metals, according as four volumes or two volumes are taken as the equivalent. —(Theory of Chemical Changes, *Am. Jour. of Science*, [2], xv. p. 230.—*L. E. & D. Phil. Mag.*, [4], v, p. 526, and *Chem. Centralblatt*, 1853, p. 849.)

seems to have arisen from "a special mineralization of vegetable remains in certain strata, which has resulted in the production of bitumen, instead of coal or lignite." This conversion, according to him, "is not attributable to heat, nor of the nature of a distillation, but is due to chemical reactions at the ordinary temperature, and under the normal conditions of climate." Mr. Wall also describes portions of wood from these deposits, which have been partially converted into bitumen, and leave, when this is removed by solvents, a residue of woody tissue. (*Proc. Geol. Soc. London*, May, 1860.) These observations have been confirmed by an eminent microscopist and chemist, whose results, lately communicated to me by himself, are not yet published.

The chemical changes, by which the conversion of woody tissue into peat, lignite and bituminous coal is effected, are too well known to be repeated here. The abstraction of variable proportions of water, carbonic acid and marsh gas may give rise either to hydrocarbons like $C_{24}H_8$, which represents idrialine and the basis of most bituminous coals, to $C_{24}H_{16}$, which is the approximate formula of the hydrocarbons of many asphalts, or to $C_{24}H_{24}$, which represents petroleum. The removal of farther amounts of marsh gas C_2H_4, may even convert bituminous coal into anthracite, as Bischoff has pointed out, and we conceive that although heat may have, in many cases, given rise to this conversion, by a subterranean coking, the change has often been the result of decompositions going on at the ordinary temperature. Anthracite, or nearly pure carbon, on the one hand, and petroleum, or carbon with a maximum of hydrogen, on the other, represent the two extremes of the process of which bituminous coals and asphalts are intermediate terms.

Petroleum, as is well known, impregnates certain rocks, from which it flows spontaneously, and the solid forms of bitumen are often disseminated throughout limestones or sandstones, from which they may be in part removed by heat, and more completely by solvents such as benzole. To such rocks the term bituminous may be correctly applied, but it is often inappropriately given to substances like coal and certain combustible schists, which contain little or no bitumen, but yield, by destructive distillation, volatile hydrocarbons, more or less resembling those obtained from asphalt or petroleum. Analogous products are however obtained by the distillation of lignite, peat, and even of wood, so that the epithet bituminous applied to hydrogenous coals and combustible schists, raises a false distinction, and perpetuates an error. We therefore proposed some time since to distinguish these so-called bituminous schists, the *brandschiefer* of the Germans, by the name of *pyroschists*. This is the equivalent of the German term, and has a precedent in the name of pyrorthite, given by Berzelius to a substance which appears to be a mixture of orthite with a combustible hydrocarbonaceous

matter. Pyroschists are well known to occur in almost every geological group from the Lower Silurian to the Tertiary, and are often, like coal, employed as valuable sources of volatile hydrocarbons, although like it they contain little or no bitumen. They may be regarded as clays or marls, holding, in a state of intimate admixture, a variable proportion of a matter approaching to coal in its chemical characters. Although frequently dark brown or black in color, they are sometimes light brown or even yellowish-gray, as is the case with the Jurassic pyroschists of the department of the Doub, and those of the Tertiary series near Clermont, both in France. Remarkable examples of this are also given by Prof. J. D. Whitney in the pyroschists from the Utica formation of the Lower Silurian series in Iowa, which were yellowish-brown, weathering to a bluish-ash color. They however blackened when exposed to heat, burning with a bright flame, and contained from eleven to twenty per cent of combustible matter. The black, glazed, and apparently very carbonaceous shales from the valley of the Hudson River, were found by Dr. Chandler to contain from one-half to one per cent of fixed carbon, and to yield no volatile combustible matters.* (*Geology of Iowa*, i, p. 359.) A pyroschist of the Utica formation, from Collingwood on Lake Huron, examined by my-

* In the Report on the Geological Survey of Iowa, (vol. i, p. 183) Prof. Whitney has given the results of a series of careful analyses of the pyroschists of the Hudson River group, (in which he includes the Utica formation). These analyses embrace specimens from the lead region of Wisconsin, from Lake Huron, the Ottawa, and the district of Quebec. They were made by Messrs. Chandler and Kimball, who removed the carbonates by the aid of a dilute acid, and determined by combustion the organic elements in the residue. In some specimens, like those noticed above, the mineral matter was almost wholly siliceous; others, like that of Collingwood, were highly calcareous, and some contained a considerable proportion of carbonate of magnesia. We select, from the eight analyses given, five of the more characteristic examples.

I. A dark chocolate, whitish-gray-weathering siliceous shale, from the lead region, without traces of organic remains. When heated in a close vessel it gave off 14·12 per cent of volatile combustible matter, leaving 6·84 of carbon, which was removed by calcination.

II. A dark gray shale, with a few graptolitic markings, from the same region.

III. A dark brown, fine grained, earthy, laminated rock, without fossils, from the islands north of Maple Cape, Lake Huron.

IV. A black bituminous shale, filled with crinoids and trilobites, from Gloucester, near Ottawa.

V. A dark brown rock, imperfectly laminated, and showing traces of graptolites, from the Ste. Anne River, below Quebec.

	I.	II.	III.	IV.	V.
Clay and sand,	73·57	80·65	34·60	48·27	37·26
Carbon,	15·03	3·97	6·63	6·99	·61
Hydrogen,	1·65	·63	·77	1·13	·83
Oxygen,	5·39	4·87	2·96	3·39	1·71
Carb. lime,	1·29	4·77	49·31	20·30	52·60
Carb. magnesia,	·76	3·40	2·53	11·48	3·42
Alumina and iron oxyd,	2·79	1·99	2·09	7·99	3·29
	100·48	100·28	98·89	99·55	99.72

self, gave to dilute hydrochloric acid from fifty-three to fifty-eight per cent of carbonate of lime, besides a little magnesia and oxyd of iron. The insoluble residue was snuff-brown in color, and, when heated, gave off a bituminous odor. When ignited in a close vessel, it lost 12·6 per cent of volatile and combustible matters, and left a coal-black residue, which, by calcination in the open air, lost 8·4 per cent additional, making in all 21·0 per cent of volatile and carbonaceous matters, and left an ash-gray argillaceous residue. This shale however contained but a very small amount of bitumen, for, on treating the residue from a dilute acid with boiling benzole, there was dissolved about one per cent of a brown bituminous matter. The residue, when heated, no longer evolved the odor of bitumen, but rather one like burning lignite, and still gave, by ignition in a close vessel, 11·8 per cent of volatile and inflammable matters. When boiled with a solution of caustic soda, this was scarcely discolored. In its insolubility, therefore, the organic matter of this rock resembles true coal, rather than lignite. Attempts have been made, on a large scale, to distill this calcareous schist of Collingwood, and it was found to yield from three to five hundredths of oily and tarry matter, besides combustible gases and water.

Overlying the Hamilton formation in Western Canada are found black pyroschists, which are supposed to be the equivalent of the Genesee slates of New York. A specimen from Bosanquet lost, by ignition in a closed vessel, 12·4 per cent, and left a black residue, which was not calcareous. A portion in fine powder was digested several hours with heated benzole, which took up 0·8 per cent of brown combustible matter. The residue, carefully dried at 200° F., then lost, by ignition in a close vessel, 11·3 per cent, and by subsequent calcination 11·6 additional, equal to 23·7 per cent of combustible and volatile elements. The calcined residue was gray in color. By distillation in an iron retort, there were obtained from this shale 4·2 per cent of oily hydrocarbons, besides a large quantity of inflammable gas, and a portion of ammoniacal water.

The pyroschists of Bosanquet belong to the Devonian series, and contain the remains of fossil land plants, so that it is not improbable that a partially decayed vegetation may have been the source of the organic matter which is intimately mingled with the earthy base of the rock. Such was probably the case in the abundant pyroschists of the coal period. In the pyroschists of the Utica formation, which are of Lower Silurian age, the chief organic remains to be detected are Graptolites, with a few Brachiopods and Crustaceans. No traces of terrestrial vegetation are known to have existed at that time, nor do the schists contain the evidences of any marine plants. The pyroschists of Mesozoic age, in several parts of Europe, contain, on the con-

trary, numerous fossil fishes, from the soft parts of which, or other animal matters, the combustible substance of these rocks is generally supposed to be derived (Dufrénoy, *Minéralogie*, iv, p. 603). It will be seen, farther on, that similar questions arise with regard to the origin of the bitumens of various formations, for while in some cases, as in the Tertiary rocks of Trinidad, they are clearly traced to a vegetable source, bitumens are also met with in Lower Silurian and Devonian limestones of marine origin, which abound in shells and corals, but afford no traces of vegetable remains. When however it is considered that the lower forms of animals contain considerable portions of a non-agotized tissue analogous in its composition to that of plants, and that even muscular tissue, *plus* the elements of water, contains the elements of cellulose and ammonia, it is easy to understand that vegetable and animal remains may, by their slow decomposition, give rise to similar hydrocarbonaceous bodies.[5] The various fermentations of which sugar is susceptible suggest analogies to the different transformations of organic tissues which have resulted in the formation of anthracite, coal, lignite, asphalt and petroleum, together with carbonic acid and a gaseous hydrocarbon as accessory products.

[5] This relation was first pointed out by me in 1849. (*This Journal*, [2], vii, p. 109.) I then endeavored to show that the albuminoid bodies might be regarded as a nitryl of cellulose, or some isomeric hydrate of carbon, and represented by the formula $C_{24}H_{17}N_3O_8$. I had already proposed to regard bone-gelatine as an analogous nitryl, $C_{24}H_{20}N_4O_8$; which corresponds to one equivalent of glucose and four of ammonia, less $8H_2O_2$. These nitryls, it was conceived, might, under certain conditions, re-generate ammonia and a hydrate of carbon. I also adduced evidence that in a case of diabetes, sugar was generated at the expense of ingested gelatine. (*This Journal*, [2,] v, p. 75, vi, p 259, *Silliman's Elem. Chem.*, p. 517.) The analyses of cartilage-gelatine, or chondrine, in like manner correspond very nearly to a nitryl formed from $C_{24}H_{22}O_{22}$ (cane-sugar) and three equivalents of ammonia. The formula thus deduced, $C_{24}H_{19}N_3O_{10}$, requires 14·7 of nitrogen.

In 1856, Dusart, starting, as he tells us, from my theoretical views, endeavored to produce the albuminoid bodies by the action of a solution of ammonia on starch, lactose, or glucose at temperature of 150° and 200° C. In this way he obtained, after several days, an azotized body, which resembled gelatine. It was precipitated by alcohol in elastic filaments, formed an imputrescible compound with tannin, and, when heated, gave off the odor of burning horn. Its proportion of nitrogen was 14·0 per cent, which is near that of chondrine. (*Comptes Rendus*, May, 1861, p. 974.) Schoonbroodt has since asserted the possibility of converting sugar into an albuminoid substance, and reiterated my suggestion that the albuminoids are veritable nitryls of the amyloids; under which convenient term he includes those hydrates of carbon which are susceptible of conversion into glucose. (*Ibid.*, May, 1860, p. 856.)

In 1861, Messrs. Fischer and Boedeker announced the production of fermentescible sugar by the action of dilute acids on cartilage, and showed that the ingestion of gelatine increases the amount of sugar in normal human urine. These authors seem by the abstract before me (*Repertoire de Chimie Pure*, July, 1861, from *Ann. der Chem. und Pharm.*, cxvii, p. 111), to ignore alike my own observations, and those of Gerhardt, who twenty years years since showed that, by long boiling with dilute sulphuric acid, there is formed from gelatine a sweet fermentescible sugar, together with a large amount of sulphate of ammonia.—(*Prècis de Chimie Organique*, ii, p. 521.)

Although we have seen that the solid asphalts, which differ from petroleum in containing less hydrogen, and a portion of oxygen, have in most cases been directly formed from organic matters by a process analogous to that which yields coal and petroleum, it appears that the latter body, like other hydrocarbons, may gradually undergo an oxydizing process, which, by removing hydrogen and adding oxygen, at last converts the liquid bitumen into substances having the characters of asphalt, of coal, or even of anthracite. Mr. Vanuxem in his Report on the Geology of New York (page 33) described many years since, by the name of anthracite, a substance which is found in the Calciferous sand-rock. It occurs in druses or cavities with crystals of quartz and calcite, and often assumes the form of drops or buttons, showing, according to Mr. Vanuxem, that it must have been introduced in a liquid, or at least a plastic state, and have subsequently hardened in a layer above the crystals, conforming to them. He described it as very brittle, pulverulent, of a shining black color, yielding by heat 11·5 per cent of volatile matter, which he regarded as water, and leaving after incineration but a small amount of ash.

A material, similar to this in aspect, occurs in many places in eastern Canada, in the Quebec group, which is regarded as the equivalent of the Calciferous sand-rock of the New York series. It fills veins and fissures, alike in the limestones, shales, and sandstones, and even in the trap rocks which traverse these. Sometimes, like that described by Vanuxem, it forms botryoidal masses; at other times it lines fissures, and, as at Drummondville and Sillery, is spread over a surface which had been previously incrusted with small crystals of calcite. The shrinking of the layer has here given rise to cracks, such as are sometimes seen in a coat of varnish. In other cases it fills fissures several inches in diameter, as on the island of Orleans, where a vein of it in shale would furnish several hundred pounds of the material, and where, as elsewhere, it has been mistaken for coal. At St. Flavien it fills a vein of an inch or two in argillite; the walls of the vein are lined with quartz, and the coal-like matter is itself cut by thin seams of quartz, of later formation. In another specimen from this locality, the vein is nearly filled with crystalline quartz, and the carbonaceous substance is found in small almond-shaped masses in the center of the vein. In the Acton copper-mine it fills irregular cracks and fissures, and sometimes forms masses several inches in diameter.

The matter from these different localities has a resinous lustre, which passes into sub-metallic in some cases. Its color is jet black, and it is very brittle and easily reduced to a velvet black powder, which has been used as a pigment. It has a conchoidal

fracture, and flies into fragments when exposed to heat. For the rest, it varies considerably in its chemical characters. The mineral from Acton, which is much harder and more metallic looking than that from the other localities, gives off, when heated to redness in a close vessel, a portion of water, but no inflammable gas or vapor, and loses 6·9 per cent of its weight, leaving a carbon which is difficult of combustion, and gives, when incinerated, 2·2 per cent of ash. Like the specimens described by Vanuxem, it approaches to anthracite in its characters. That from the other localities examined gives off when heated a greater or less proportion of combustible vapor, which condenses, in part, into a tarry liquid, having an offensive odor very distinct from the product of the distillation of coals or pyroschists. Carefully selected specimens yield, by incineration, only a few thousandths of ash, apparently due to accidental impurities. In a specimen from Quebec the volatile matters equalled 19·5 per cent; in one from Orleans Island 21·0; in one from St. Flavien 15·8, and in another, six miles from the last, 24·5 per cent. The latter, when exposed to heat, swells up, and leaves a porous coke, the fragments cohering like those of a caking coal. The same is true, to a less extent, of that of Orleans. These matters are not affected by benzole, with the exception of the last mentioned, which appear to contain a small amount of soluble substance. The mode of occurrence of these matters shows that they have once been in a liquid state, and, as the limestones of this group are in many parts distinctly bituminous, there can be little doubt that the liquid carbonaceous matter was bitumen, which has since been slowly oxydized, indurated, and converted into these insoluble, infusible coaly and anthracitic bodies.

This view is confirmed by the examination of a bitumen which appears to be in the very act of changing. In the Devonian limestones of Canada, there are beds of fossil corals, which are impregnated with petroleum. At the outcrop of these, where the strata have been for ages exposed to the weather, the petroleum is replaced by a black matter, which lines the cells, and, having lost its oily character, no longer repels the water like the still oily corals within. Benzole, which readily dissolves the bitumen from these, does not affect the black color of the weathered corals. A fragment of a *Favosites* impregnated with this black matter was crushed and treated with dilute muriatic acid, which removed the carbonate of lime of which the coral was composed, and left five per cent of a brownish-black residue. This, when exposed to heat, burned with flame, without melting, and left a bulky coherent coaly residue, which gave a little ash. When treated with a large amount of boiling benzole (coal-naphtha) the residue gave up only 16·5 per cent of soluble bitumen, and the subsequent analysis of the insoluble residue gave volatile

and combustible matter 28·1, carbon 67·7, ash 4·2=100·0. From these experiments it appears that the soluble and liquid bitumen of the corals is, in the weathered portions, converted, in great part, into an insoluble and infusible hydrocarbonaceous matter, resulting probably from a slow oxydation. It is not improbable that a less advanced stage of this process might afford the solid, but fusible and soluble bitumen which impregnates rocks of the same series in other localities. Thus in Kineardine on Lake Huron, immediately overlying massive beds of a somewhat bituminous limestone of the Corniferous formation, are found thinner slaty beds of a dark chocolate color, interstratified with pale yellowish earthy layers. These latter contain no combustible matter, but the dark colored beds burn with a smoky flame, although the hydrocarbonaceous substance is for the greater part insoluble in benzole. In quarrying at this place however, specimens were obtained of a thin shaly bed, which when pulverized and treated with benzole lost 12·8 per cent of soluble bitumen, and left a nearly white calcareous residue, free from carbonaceous matter. Such a rock as this is rightly designated a bituminous limestone, although the beds at the outcrop, which contain an insoluble hydrocarbon, and approach to a pyroschist in character, are probably but altered portions of the same bituminous rock. The interstices of a porous crystalline dolomite from the Grand Manitoulin Island, are filled with brown asphalt, which melts and exudes by a gentle heat, and is completely soluble in benzole. It forms from 7·4 to 8·8 per cent of the rock. An altered form of petroleum is also found near the oil wells of Enniskillen, where the product of the natural oil springs appears in the form of large superficial beds of a soft solid, which is slightly adhesive at ordinary temperatures, and has a specific gravity about that of water. According to Delesse, it solidifies after fusion at 83° centigrade. He found it to consist of bitumen soluble in benzole 62·5, insoluble organic matters, (the debris of recent vegetation), 24·8, clay and sand 12·7=100·0. The bitumen, left by the evaporation of the benzole, is solid and but slightly ductile.[6] This product evidently results from a drying up, and probably a partial oxydation of petroleum, which has been changed into a matter approaching to asphalt in its properties.

[6] Delesse, *Matériaux de Construction à l'Exposition de* 1855, page 390. On page 381 of the same volume Delesse has described a peculiar brownish-black compact and tough rock, from Promina in Austria, which consists of 59·0 parts of a crystalline limestone, 9·0 parts of clay, and 32·0 parts of a brownish-black combustible matter, which is fusible, and gives off by heat acid vapors, leaving a residue of only 3·5 parts of fixed carbon. It is almost completely insoluble in benzine, and is, by Delesse, designated as a lignite, from which however it is distinguished by its fusibility. It would seem to be a hitherto undescribed matter intermediate between lignite and asphalt.

It now remains to speak of the geological distribution of petroleum in the Palæozoic rocks of this country. Apart from the matters just described from the Quebec group, bitumen occurs at two distinct horizons in the New York series. For reasons which will be apparent farther on, we recall the principal divisions in this series. At its base are the siliceous sandstones of the Potsdam formation, to which succeeds the Calciferous sand-rock. This is, for the most part, a dolomite, occasionally containing small quantities of gypsum and other earthy sulphates. The bitter saline springs, which issue from this and the succeeding limestones, probably have their source in this dolomitic formation. The Chazy limestone, which immediately overlies this, is magnesian in its lower part, and, lithologically, affords a transition from the dolomites beneath, to the great mass of pure limestones which form the Birdseye, Black River and Trenton formations, and are often included under the general name of the Trenton group. In this we meet for the first time with petroleum, although in much less abundance than in the higher rocks. In the township of Pakenham, the large Orthoceratites of the Trenton limestone sometimes hold several ounces of petroleum in their chambers, and it has been met with under similar conditions in Lancaster. It has also been observed to exude from the fossil corals of the Birdseye limestone at Riviére a la Rose (Montmorenci). The limestones of this group, which are generally more or less bituminous to the smell, are peculiarly so in some parts of the county of Montmorenci, and not only give off a strong odor when struck, but, when burned for lime, evolve an abundant bituminous vapor on the first application of heat. A spring which affords small quantities of petroleum issues from the Utica formation, on the Grand Manitoulin Island, and Dr. Beck has described a similar one from the Hudson River group, in Guilderland, near Albany, New York. Both of these probably have their source in the underlying limestones, which are characterized by beds and nodules of chert, and by silicified fossils, not less than by the presence of petroleum.

To these limestones succeed, in ascending order, the pyroschists of the Utica formation, followed by the shales of the Hudson River group. This terminates the Lower Silurian or Cambro-Silurian[1] system, and, taking the Potsdam of New York as the basis, constitutes a lithological series, which is reproduced, with a very remarkable parallelism, in the Middle and Upper Silurian and Lower Devonian rocks about to be mentioned. The siliceous strata at the base of the first series are repeated in the Oneida and Medina conglomerates and sandstones, while the

[1] The term Cambro-Silurian, first suggested by Prof. Phillips, is adopted by Jukes to designate the Lower Silurian series of rocks. (*Trans. Royal Irish Acad.*, xxiii, p. 564.

great mass of dolomites, with gypsum and salt, which makes up the Clinton, Niagara, Guelph and Onondaga formations, represents on a great scale the similar dolomites of the Calciferous formation. The lithological representative of the Trenton group next appears in the Corniferous formation, composed, like the former, of pure limestones, with chert beds, silicified fossils, and petroleum. To these succeed in western New York the pyroschists, called the Marcellus shales, closely resembling those of the Utica formation, and followed by the Hamilton group, lithologically similar to that of the Hudson River, and overlaid in its turn, by sandstones of the Portage and Chemung group, which may be compared to those of the Potsdam and Oneida formations.* It should be mentioned however that the repetition of the pyroschists at the base of these sandstones, constituting the Genesee slates, has no known representative in the Lower Silurian series.

It is in the Lower Devonian limestone, or Corniferous formation, that the greatest amount of petroleum occurs, although Mr. Hall observed that the dolomites of the Niagara formation in Monroe county, New York, frequently contain mineral pitch; which is sometimes so abundant as to flow from the rock, when this is heated in a lime-kiln. Concretionary nodules holding petroleum have also been observed in the Marcellus and Genesee slates, while the higher Devonian sandstones in New York and Pennsylvania are often impregnated with petroleum, and from these, and from still higher strata, issue the oil springs of those regions. It is probable however that the source of the oil in these superior strata is to be found in the Corniferous limestone, from which the petroleum of western Canada is undoubtedly derived, since in Enniskillen this formation is covered only by 200 or 300 feet of Hamilton shales, the Marcellus pyroschists being absent from that region; while at Tilsonburg the limestone appears at the surface, and wells bored into it have yielded considerable quantities of petroleum. Different observers have noticed the occurrence of petroleum in the rocks of this formation, and remarkable instances of it may be seen in several parts of western Canada. In the township of Rainham, on Lake Erie, the shells of *Pentamerus aratus* are sometimes found to have an inner cavity, lined with crystals of calcite, and filled with petroleum. Coralline beds impregnated with petroleum are found in Wainfleet

* The late Prof. Eaton had a perception of this curious lithological parallelism, in successive geological series, when he classed all stratified rocks in three divisions, carboniferous, quartzose and calcareous; which he supposed to be repeated in the same order in each geological series. By carboniferous, he meant simply argillaceous and slaty rocks, in which, according to him, coal and carbonaceous schists might occur. In the carboniferous division of his primitive series, he placed gneiss and the crystalline schists. (*Geol. Text Book*, 1832, and *this Journal*, [2], xxxiii, p. 281).

and in Walpole, in the latter instance immediately beneath a layer of chert, but I have more particularly examined them in the township of Bertie, which is on the Niagara River, opposite to Buffalo. Here, in a quarry, are seen massive beds, slightly inclined, composed of a solid crystalline encrinal limestone, which appears not only destitute of petroleum, but from the water, by which it is impregnated, to be impermeable to it. In some of these beds are large corals of the genus *Heliophyllum*, the pores of which are open, but contain no oil. Two beds however, one of three, and one of eight inches, which are interstratified with these, are in great part made up of species of *Heliophyllum* and *Favosites*, the cells of which are full of petroleum. This is seen, in freshly broken masses, to be absent from the solid limestone, which forms the matrix of the corals, and resembles in texture the associated beds. As the fractured surfaces of the oil-bearing beds become dry, the oil spreads over them, and thus gives rise to the appearance of a continuous band of dark oil-stained rock, limited above and below by the lighter limestone, from which, however, it is separated by no planes of bedding. The layer of three inches was seen to be twice interrupted in an exposure of a few feet, thus presenting lenticular beds of the oil-bearing rock. Besides the occasional specimens of *Heliophyllum* without oil, disseminated in the massive limestone, a thin and continuous bed of *Favosites* is met with, which is white, porous, and free from oil, although beds both above and below are filled with it. It is from the weathered outcrop of one of these that was obtained the specimen already described on page 164, in the cells of which was found the infusible and insoluble product of the oxydation of petroleum. When the oil-bearing beds are exposed in working the rock, the oil flows out and collects upon the water of the quarry. Besides the two beds noticed above, there are said to be others, which were concealed by water at the time of my visit. The facts observed at this locality appear to show that the petroleum, or the substance which has given rise to it, was deposited in the beds in which it is now found, at the formation of the rock. We may suppose in these oil-bearing beds an accumulation of organic matters, whose decomposition, in the midst of a marine calcareous deposit, has resulted in their complete transformation into petroleum, which has found a lodgement in the cavities of the shells and corals immediately near. Its absence from the unfilled cells of corals, in the adjacent and interstratified beds, forbids the idea of the introduction of the oil into these strata either by distillation or by infiltration. The same observations apply to the petroleum of the Trenton limestone, and if it shall hereafter be shown that the source of petroleum (as distinguished from asphalt) in other regions, is to be found in marine fossiliferous limestones, a step will have been

made towards a knowledge of the chemical conditions necessary to its formation.

The natural oil springs, which occur in various parts of western Canada, are upon the outcrop of the Corniferous limestone, or of the overlying Hamilton shales, and are along the line of a broad and low anticlinal, which runs nearly east and west through the district. In the township of Dercham, where small quantities of oil rise to the surface in several places, the Corniferous formation is overlaid by about forty feet of clay and sand, after sinking through which the limestone was bored to the depth of thirty-six feet. From this opening a few barrels of petroleum were obtained. Oil springs abound for several miles along the Thames, about sixty miles to the westward of Dercham, and borings into the limestone beneath have furnished considerable quantities of oil, although not sufficient, perhaps, to be of great economic importance. The principal oil wells of Canada occur in Enniskillen, about twenty miles to the northward of the last. Here numerous oil springs are found, and the thickened petroleum, mixed with earthy and vegetable matters, described on page 165, forms layers of considerable extent at the surface of the ground, and around the roots of growing forest trees. Two of these layers have together an area of more than two acres, and a thickness which varies from a few inches to two feet. They are locally known as gum beds. In sinking a well in the vicinity of an oil spring in this region, there was found, beneath a depth of ten feet of clay, and reposing upon four feet of gravel, a layer of bituminous matter like that just described, from two to four inches in thickness. It is easily separable into thin laminæ, which are so soft as to be flexible, and show upon their surfaces the remains of leaves and of insects, which had become imbedded during the slow accumulation and solidification of the bitumen. This little deposit, which is mingled with a considerable proportion of earthy matter, is instructive, as showing the manner in which beds of bituminous rock may sometimes be produced from previously formed sources of petroleum.

The Corniferous limestone in Enniskillen is overlaid by about two hundred feet of marls and soft shales abounding in the characteristic fossils of the Hamilton formation. To this succeed from forty to sixty feet of Quaternary clays and sands of fresh-water origin, through which the scanty natural oil springs rise. On sinking wells, there is generally found, reposing immediately upon the shales, a layer of coarse gravel, holding large quantities of petroleum, which is the oil of the so-called surface wells, and has accumulated beneath the clays. It is darker and thicker than that obtained directly from the rock below, on boring which fissures or seams are met with, from which petroleum issues in abundance, and often with great force, sometimes attaining the

surface, and often rising above it, constituting the flowing wells. These oil-bearing veins are met with at depths varying from forty feet to one and two hundred feet in the rock, and in borings near together the oil is often met with at very unequal depths. Adjacent borings sometimes appear to be connected with the same vein, and to affect each other's supply. The deepest well in this region was estimated to yield, when first opened, 2000 gallons in twenty-four hours, and at present, when it is allowed to flow for some time, the supply in many of the neighboring shallower wells is found to fail. The facts observed in this region seem to show that these veins are fissures running obliquely downwards to the great reservoir of petroleum which is probably in the underlying Corniferous limestone. The oil wells in this township are confined to two districts, the more abundant one being about six miles south of the other. From the results of an unsuccessful boring made on an intermediate point, it appears that these two districts are on two slight anticlinals, subordinate to the great axis already mentioned. This anticlinal structure appears to be a necessary condition of the occurrence of abundant oil wells; the petroleum being lighter than water accumulates in porous strata, or in fissures in the higher part of the anticlinal, and in obedience to a hydrostatic law, rises through openings to heights considerably above the water-level of the region. Large quantities of light carburetted hydrogen gas are found in the Palæozoic rocks of the vicinity, and seem to be in many cases accumulated in the subterranean anticlinal reservoirs, since borings sometimes yield both gas and oil, or gas alone. Water, sometimes, but not always, more or less saline, often accompanies the petroleum, and frequently replaces the latter in wells that have been for some time wrought. I do not conceive that the gas has any necessary connection with the oil, since large quantities of it are found in rocks which underlie the Corniferous limestone. If however, as is not improbable, portions of it were generated, and now exist in a condensed state in the oil-bearing strata, its elasticity would help to raise the petroleum to the surface.

The accumulation of the petroleum along lines of uplift, and its escape through the fissures accompanying this disturbance, must evidently date from a remote geological epoch. Porous beds, like the Devonian sandstones, or the Quaternary gravels, have however served as reservoirs in which the oil has accumulated, while argillaceous and nearly impervious strata, like the marls of the Hamilton group, and the fresh-water clays which overlie the gravels in western Canada, have in a great measure prevented its escape. Hence, it would appear that the Devonian sandstones of Pennsylvania and northeastern Ohio are filled with oil, which has risen from the limestone beneath, while, over

a great portion of western Canada, this limestone was ages ago denuded, and has lost the greater part of its petroleum.

In the easternmost part of North America, and at the extremity of the peninsula of Gaspé, petroleum is again met with, issuing from sandstones which belong to the base of the Devonian series. The oil springs are here found over a considerable area, along an anticlinal, and may yet prove to be of economic importance. Beds of thickened petroleum, like those of Enniskillen, are here met with. Near to Cape Gaspé there is a remarkable dyke of amygdaloidal trap, ten or twelve yards in breadth, the cavities of which are often lined with chalcedony, or with crystals of calcite and quartz. Many of these cells are filled with petroleum, which in some cases has assumed the hardness of pitch. The odor of the bitumen, which may be perceived to a considerable distance, has caused the name of Tar Point to be given to the locality.

In concluding these notes, I beg to call the attention of geologists to the importance of determining, as far as possible, the nature and the age of the rock formations to which the petroleum of different regions is indigenous, carefully distinguishing those cases in which its occurrence is evidently the result of a secondary process. As an instance of this, it is most desirable to determine whether the oil wells of the Carboniferous rocks in Ohio and Virginia derive their supplies, like those of Pennsylvania, from the Lower Devonian limestone, or whether there exists, in the Carboniferous system, a third oil-bearing horizon, analogous to those of the Trenton and Corniferous limestones.

Montreal, Dec. 20, 1862.

ART. XIX.—*Origin of the Indian Race of Hayti;* by J. A. VAN HEUVEL, of St. Lawrence Co., New York.

AT the period of the discovery of the West India Islands by Columbus, they were inhabited by two very dissimilar races. The larger and more northern of them, Hayti, Cuba, and Porto Rico, and likewise the Bahamas, were possessed by a people of mild and unwarlike character, who were of the same origin. The smaller islands south of them, extending in a chain to South America, were at the same time inhabited by the fierce and warlike Caribees, who made constant aggressions upon their neighbors. That the inhabitants of the former islands were all of the same race is expressly stated by Columbus. In a letter which, on his return from his first voyage, he addressed to the Treasurer of Spain, he says, "there is no difference in their countenance and manners, and they all speak the same language."[1] Of the gentle

[1] Navarette, ii, p. 385 (Paris edition).

and peaceable character of the Haytians, he in the same letter thus speaks: "They are without arms, which they know not how to use, being of a timid disposition. They have canes dried in the sun, the ends of which are pointed with a piece of hard wood sharpened; but even this weapon they dare not use, for it often happened, that on our sending two or three men to visit some of their towns, all the inhabitants fled in disorder."[3]

They were also of an extremely amiable and benevolent nature. In the intercourse which Columbus had with them, he met with a most friendly and generous reception, accompanied with the greatest respect and even veneration. As he approached Hayti the first time with his vessels, and, in sailing along it, one of them was wrecked on the coast, the Cacique in whose dominions the accident occurred, on hearing of it, directly sent some canoes which brought away all that was in the vessel. He came to the shore, and took care that none of the goods should be lost, himself remaining to guard them, and had them taken to two houses he had appointed, sending a message to Columbus not to be concerned, and he would give all he had to repair his loss.[3] "The Indians," says Herrera, "so affectionately gave them help, that it could not have been better done in Spain, for the people were gentle and loving."[4] In a letter which Columbus addressed to his royal patrons, Ferdinand and Isabella, he observes: "The people are so affectionate and tractable that I swear to you there is not a better people nor a better country in the world. They love their neighbor as themselves, and their conversation is the sweetest in the world, being pleasant and always accompanied with a smile."[5]

Hayti, Cuba, and Porto Rico, at the period of their discovery, were most densely populated. The entire number of their inhabitants, according to Las Casas, was six millions, and those of Hayti were half that number. Oviedo states their whole population at three millions, and that of Hayti at somewhat more than one million; which estimate Bryan Edwards, in his History of the West Indies, thinks to be probably the most correct.[6]

But, being inhabited by a race so gentle and unwarlike, they were without difficulty immediately subjugated by the Spaniards. After their conquest their history is as short as it is melancholy. The rigorous treatment which the Haytians experienced from their invaders in being forced to labor in the mines of their island, which soon broke their constitutions, unused to toil, almost entirely swept off their numerous population, in less than half a century. In 1509, but seventeen years after the first landing of the Spaniards, they were reduced to sixty thousand.

[3] Navarette, ii, p. 777, &c.
[4] Dees, Book I, Ch. 18.
[5] Robertson's America, Book I.
[6] Robertson's America, Book I, Note 15.
[6] History of the West Indies, Book I, Ch. 3.

After five years more there remained but one third of this number, and in 1533 they amounted to only four thousand.[7] Subsequently a small part of this remnant escaped destruction. "A young Cacique, placing himself at the head of the few that remained, made a resolute resistance to their conquerors. Driven at length to extremities, he retired to the fastnesses of inaccessible mountains, from which he continually sallied forth and harrassed the Spanish inhabitants, who in the end, struck with the heroism and the moderation he showed in the use he made of the advantages of his position, suffered him and his adherents to leave their retreats and reside unmolested in any part of the island. Their descendants continued to inhabit it for a length of time; but their numbers gradually diminished, and in 1716 amounted to only one hundred souls."[8]

The population of Cuba shared the same fate, but the destruction was not so entire. From information given me by intelligent gentlemen from Havana, it appears that there are still at the present time some descendants of the ancient race near St. Jago, having the following villages: Holquin, Cobre, Vallamo, Puerto Principe, and Guanaja, whose aggregate population is two thousand.

From what region this ill-fated race, of so amiable, gentle, and peaceful a character, was derived, is an interesting inquiry. From their greater proximity to North America than to the southern continent, it might at first view be thought that they came from Florida. But their character, so different from that of the tribes in general of that country and the adjacent regions, who are brave and warlike, is opposed to this supposition, and it might be considered more probable that they passed to the islands from the not very distant coast of Yucatan.

But Bryan Edwards advances another theory of their origin. "The antipathy," he remarks, "which the Caribees manifested to the unoffending natives of the larger islands appears extraordinary, but it is said to have descended to them from their ancestors of Guiana. They considered them (the Haytians) descended from the Arrowacks of South America, with whom the Caribees of that country are continually at war."[9]

Having once passed some time in British Guiana, and found that the Arrowacks are one of the tribes of that country, and feeling an interest in this question, I endeavored to obtain some information as to their manners and language; and the facts which I collected, on comparing them with the accounts preserved of the Haytians, fully support the tradition preserved by the Caribees as to their origin, as related by Mr. Edwards.

I ascertained that the Arrowacks are spread along the whole

[7] Ogilby's History of America. [8] Jeffrey's Natural and Civil History of America.
[9] History of the West Indies, Book 1, Ch. 3.

coast of British Guiana and Surinam adjoining it. They are at the mouths of the rivers that fall into the Atlantic, but not higher up upon them. Their appearance is very similar to that of the Indian natives of South America in general. They paint their body all over with a red coloring matter made from the bruised seeds of arnotto mixed with oil. They wear strings of beads around the arms, and chains of the same or of shells about the neck. A silver ornament is sometimes worn at the ears, and a longitudinal piece of wood is inserted in an incision made below the under lip. They rely for subsistence on hunting and fishing, and cultivating around their cabins cassava or manioc, maize, potatoes, plantains, &c.—chiefly cassava, which is prepared for food in a remarkable manner. The root, which is the part eaten, is first grated, and the juice, which is poisonous, is expressed. The grated mass is spread on a flat form, and baked into cakes twelve or fourteen inches wide. The juice is divested of its poisonous quality by ebullition, the foam as it rises being continually removed, and is then used as a condiment with their daily dish, which is prepared from a variety of articles, venison, fowl, fish, &c., put together in a pot, and a portion of this juice added, with a large quantity of pepper, and then boiled. It makes a delicious dish, highly valued by the Arrowacks; and, as the pepper is an important ingredient in it, it is called in their language, *hachi-duada*, signifying pepper-pot—from *hachi*, pepper, and *duada*, pot. The cassava cakes are eaten with it.

Their cabins are of a square form, of greater length than breadth, constructed of four stakes planted in the ground, open on all sides, with an angular roof, which is covered with leaves of *troobes*, a species of palm. In them are suspended their hammocks for sleeping, in which also they sit or recline during the day. They are a net-work made of the fibres of the *pita*, another species of palm. In the middle of the cabin a fire is continually kept, to repel by its smoke the approach of mosquitoes, which abound in their torrid clime.

In support of the hypothesis of Bryan Edwards, the following proofs may be adduced:

1. The Arrowacks bear a great resemblance in their character to the Haytians. They are, like them, mild, gentle, and benevolent. As such they have uniformly exhibited themselves to the Europeans with whom they have had intercourse. When the Spaniards, in their first expeditions to the Orinoco, had excited against them the general hostility of the Indians, the Arrowacks alone were friendly to them. Lawrence Keymes, who commanded the second expedition made by Sir Walter Raleigh to this river, in 1596, remarks: "The Caribes, the Ciawanis, Titivivas, and all other nations, far and near, were ready to join against them, except the Arawacas, who were the only nation in

whom they could trust." And again: "The Indians of Moruga (a river near the Orinoco) sought by all the means in their power to unite all nations into an alliance to invade the Arwacees for being guides to the Spaniards, in showing them their towns and betraying them."[10] To the friendship thus early shown to the Spaniards they ever remained constant. Gumilla, in his *History of the Orinoco*, written a century and a half after, observes: "They are much more attached and more faithful to the Spaniards than any of the nations who have been discovered on this river or in the neighboring regions, for as soon as they are informed of any attack intended against them, they secretly inform them of it."[11]

Bancroft, in his *History of Guiana*, says that in temper and disposition they are cheerful, humane, and friendly; but somewhat timid and cowardly. Stedman, in his account of Surinam, remarks of those in that province: "They are not only at peace with other Indian nations, but are peculiarly attached to Europeans, who in return possess for them the strongest esteem. A more peaceable people does not exist in the universe."

2. The existence of an implacable animosity between the Caribees of Guiana and the Arrowacks, alleged by the insular Caribees as the cause of their enmity to the Haytians, whom they considered of the same nation with the Arrowacks, was confirmed by inquiries I made on the subject. At the commencement of the Dutch colonies, Essequibo, Demerara, and Berbice, which now belong to England, forming British Guiana, these nations were engaged in constant wars together. In the old maps of this country are marked three places on the Essequibo river at which they had engagements. The last was a very sanguinary one, so that the river was colored with blood, and the Arrowacks were defeated, and fled to some distance on the river below. Their mutual hatred and antipathy continues to this day as intense as ever. It is the height of offense to an Arrowack to be called a Caribee, and to a Caribee to be thought an Arrowack.

A missionary in Surinam at the close of the last century, in his account of it, observes: "The Arrowacks had long wars with the Caribees, until the government determined to put an end to them, by declaring to both that if either commenced hostilities against the other it would be considered an enemy of the colony."[12]

3. A comparison of the language of the Haytians and Arrowacks supports the identity of the two nations. From the early destruction of the Haytians, and the little care taken to preserve a knowledge of their language, the means of making this comparison are scanty. Yet a few words of it have been preserved, and are placed in the following table, which will be seen to agree

[10] Cayley's Life of Raleigh, ii, pp. 342, 331.
[11] History of the Orinoco, chap. 10.
[12] Quandt, Nachricht von Surinam.

with the Arrowack, the words of which are taken from a vocabulary I formed of this language:

	Arrowack.	Haytian.
Pepper,	Hachi,[13]	Axi.
Maize,	Mareesee,	Ma-i-zi.[14]
Canoe,	Canoa,	Canoa.
House,	Bahu,	Boa, Bohio.
Hammock,	Hammaka,	Hamaca.
Stone,	Seeba,	Ciba.

The following are the authorities for the Haytian words:

Axi.—"They gave the Spaniards a sort of spice which they called Axi." Herrera, Dec. I, Book I, Ch. 7.

Maizi.—"They gave the Spaniards a sort of grain which they call Maizium." Martyr, Decade I, Book I. The author wrote in Latin, and his translator has rendered the word in English Maizi.

Canoa.—"Their boats they call Canoas." Martyr, Dec. I, Book I.

Hamaca.—"The beds of the Lucayans are called Hamacas." Herrera, Dec. I, Book I, Ch. 12.

Ciba.—"On the second visit of Columbus to the Cacique of Hayti, he presented him, among other valuable jewels, with eight hundred beads of stone, which they call Cibas." Herrera, Dec. I, Book II, Ch. 9.

Boa, Bohio.—"The word of the Haytians for house is Boa." Martyr, Dec. I, Book I. As Columbus sailed from Cuba to Hayti, the Indians he had on board, whom he had brought from the Bahamas, called the latter island Bohio. It seemed that it signified a land full of cottages. Herrera, Dec. I, Book I, Ch. 15.

Martyr was the cotemporary of Columbus, and his work, *Novus Orbis*, was founded on information received from Columbus himself, and from his companions in his voyages.

It may be said that the above Haytian words, which the Spaniards adopted into their language, were spread by them along the coast of Guiana among the Arrowacks; but for this supposition there is no foundation, since it is not probable that the Arrowacks would adopt new words for things well known to them, and for which they must have had names; and, farther, in the language of the Caribees on the Orinoco, who from their frequent intercourse with the Spaniards would equally have adopted them, these words are not found, as is shown in the following table.

	Haytian.	Caribees.
Canoe,	Canoa,	Couriara.
Hammock,	Hamaca,	Acalto.
Stone,	Ciba,	Tebou.
Pepper,	Axi,	Pomoui.
Maize,	Maizi.	Awasse.

[13] The initial letter H in the Arrowack is only an aspirate.

[14] This word is of three syllables, and taken from a Spanish writer; the vowel i has the sound of the English ee.

The Arrowack language resembles in its structure the Haytian. Herrera says the Haytian was easy to be pronounced and learned, and Charlevoix says that we may judge of its softness by some words which have passed into our language.[15] Such is the character of the Arrowack, which abounds in vowels and liquids, and is remarkably soft and melifluous. Bancroft, who resided sometime in British Guiana, says, in his history of this province, that it is distinct and harmonious, and not unlike the Italian in softness and multiplicity of vowels.

The following Arrowack words, taken from my vocabulary, show this:

	Arrowack.		Arrowack.
Sun,	Hadalee.	Earth,	Woonabo.
Year,	Weewa.	Water,	Woonee.
Tree,	Ada.	Island,	Careeree.
Hill,	Hoorooroo.	Lightning,	Belbellairo.

4. It is not only very probable, but there are some facts furnishing decided evidence, that the Arrowacks of Guiana passed to the northern islands in the West Indies, Hayti, Cuba, &c. Sir Walter Raleigh, in the narrative of his expedition to the Orinoco in 1595, states that they had spread along the coast as far as this river. "The nations," he says, "that dwell on the south of the Orinoco are Arrowacks;" and, in another place, observes that "he came to a town of the Arrowacks north of the Orinoco."[16] Humboldt mentions them among the nations now in the Spanish province of New Andalusia, which is between this river and the northern coast. Being spread so far to the north, they might easily pass to the island of Trinidad, which lies near the Orinoco. But that they made this transit is not merely conjectural. Sir Robert Duddeley, in the account of his voyage to Trinidad in 1595, found in *Hackluyt's Collection*, vol. iv, gives a list of words of the language spoken in this island, nearly all of which are similar to the Arrowack. But, for brevity's sake, we give only a few in the following table:

	Trinidad.	Arrowack.
Arrow,	Simara,	Simara.
Maize,	Maureesee,	Mareesee.
Bread,	Callit,	Calee.
Stone,	Sebath,	Seeba.
Fire,	Hecket,	Hekeehee.

Du Tertre, in his *History of the West India Islands*, says that the Caribee inhabitants of the smaller islands, in 1640, united in a general war against the Arrowacks in Trinidad;[17] which not only confirms the above account, but also shows that the Arrowacks were then very numerous on this island.

[15] History of St. Domingo.
[16] Cayley's Life of Raleigh, Appendix No. IX.
[17] Histoire des Antilles.

From Trinidad, the Arrowacks could readily pass through the smaller islands to the larger ones, Hayti, Cuba, and Porto Rico. After reaching St. Vincent's, all the rest of the Caribee Islands are but a short distance from each other.

But that the Arrowacks passed through the smaller islands, there is conclusive evidence in the fact that they once occupied these islands, when the Caribees conquered and became masters of them.

The missionaries Rochefort and Labat, who each wrote a history of the islands, relate that the females in them spoke a different language from the men, the origin of which they thus give. "The women of the Caribee Islands," says Rochefort,[18] "have words and phrases that are never used by the men except in the way of raillery, which had this origin. The Caribees of Dominica say that these islands were once inhabited by Arrowacks, and that they conquered them, and, killing all the men, reserved the females for wives, who retained their language, which resembles that of the Arrowacks of Terra Firma; and it is to be noted that, among the Caribees of the continent, the males and females speak the same language." Labat[19] observes, "the Caribees of the islands have three languages; one common to all, another peculiar to the warriors and elder men, which is used in their public assemblies, and a third spoken only by the females, and wholly different from that of the men, who consider themselves dishonored by speaking it;" from which he concludes that without doubt the Caribees are strangers in these islands, having conquered them, killing all the males and reserving the females. The language of the females," he says, "was easier pronounced and learned than that of the males."

The inhabitants of Hayti were accustomed to navigation, and probably made distant voyages, as they had boats of a large size, some of them having eighty rowers, or forty on each side.

Further, they and the people of the other islands had a knowledge of South America.[20] As Columbus on his first voyage was pursuing his course from the Bahamas in pursuit of further discoveries, some Indians he had on board, whom he had brought with him, pointing to certain land at a distance called it Bohio, others Babeque, by which he thought they meant Hayti; but it appeared afterwards it was not this island, as they called it by another name, Caribana.[21] The northern coast of South America throughout, according to Martyr, was called Caribana, from Caribees being spread along the whole of it. In the second voyage of Columbus, as he sailed through the islands of the Caribees, some females captured by them from the other islands, who fled to him for protection, said that towards the south were many

[18] Histoire des Antilles, Book II, Ch. 40.
[19] Voyages aux Isles de l'Amérique.
[20] Martyr, Dec. I, Book I.
[21] Herrera, Dec. I, Book I, Ch. 15.

islands, some inhabited, others not, which they called by their names; and that there was a continent which was very great, from which canoes had come to traffic.[22] While at Hayti, the Indians said to him that there was another large island, called Yamaje (Jamaica), and that Hayti and Yamaje were but ten days' sail from Terra Firma, from which canoes had come with abundance of loads to barter.[23]

On the other hand, there is evidence that the Arrowacks were accustomed to make voyages to the West India Islands. Sir Walter Raleigh says that, in going up the Orinoco, "we took two canoes laden with bread bound for Maigueritta in the West Indies, which the Arrowacks in them proposed to carry thither to exchange;" and he speaks of a town on this river "where there was a continual market of women for three or four hatchets, and they are bought by the Arawacas, and by them sold in the West Indies."[24] In a journal kept by a resident of British Guiana, of which I had a perusal, I found an interesting passage relating to this subject. He was by name James Glen, and in 1810 took up a residence for some time in the Indian country at the head of the river Essequibo. He appears to have had the advantages of education and a scientific taste, from several notices in his journal of the Indian nations and the natural history of the interior of Guiana. Some of his remarks I transcribed, among them the following: "Previous to the year 1500, the Arrowacks were accustomed to go from the rivers of Guiana to the large islands"—which could be no other than Hayti and Cuba. The year mentioned was eight years after the discovery of Hayti by Columbus, and the settlement of the Spaniards in it, which probably caused the intercourse of the Arrowacks to cease.

While, however, the general population of Hayti, Cuba, and the Bahamas is shown with the greatest probability to have come from South America, it is not maintained that some of the inhabitants of Hayti and Cuba may not have been derived from other parts. In Hayti was a tribe called Ziguayos, different in their character from the inhabitants of it in general, and who have been supposed to be a Maya colony from Yucatan. It is very probable indeed, from the situation of Hayti and Cuba, that there was an emigration from Yucatan to these islands. In regard to Cuba, two positive facts are stated by Martyr, which give reason to believe that there had been an emigration to it from that part of the continent. At the place on the coast of Yucatan where Grijalva first landed, he made use of Indians of Cuba as interpreters, and at Coluacan, to which he afterwards

[22] Herrera, Dec. I, Book I, Ch. 12.
[23] Navarette, ii, p. 260.
[24] Cayley's Life of Raleigh, i, pp. 223, 249.

came, the language of the people, he says, resembled that of Cuba.[25]

But it may be said that, allowing that the reasons which have been offered to show the Arrowacks and Haytians to be the same nation are sufficient to establish their identity, it does not necessarily follow that the latter are derived from the former. May not the Haytians have sent colonies to the coast of Guiana from whom the Arrowacks are derived, instead of themselves descending from the Arrowacks? To this we reply, in the first place, that the Arrowacks appear to be the original proprietors of that coast. Its rivers, Essequibo, Berbice, Demerara, have Arrowack names. Essequibo signifies a deer; Berbice is from Guarapuche, the Arrowack name of this river. There is a river of the same name north of the Orinoco. Demerara is from the Arrowack Imirari. The Portuguese who first settled on this coast called it Rio D'Imirari, as they say Rio de Janeiro, whence the name Demerara. Simara, the name of a river north of the Orinoco, is also an Arrowack word, signifying arrow. Orinoco is probably also Arrowack. Water in Arrowack is *Woonie*. In Trinidad, according to Sir Robert Duddely, it is *Orononie*, which name may have been given to this river as "the water" emphatically, from the vast flood which it pours out.

Next, we observe that the principal plants cultivated by the Haytians belong to South America, of which may be mentioned, in particular, cassava or manioc, and their manner of preparing it for food is the same as that of the Arrowacks, which has been described. "The Haytians," says Martyr, "never eat *jucca*, by which name this plant is sometimes called by them, except it is first sliced and pressed, and then baked or sodden; for it is full of liquor which is a strong poison, that causes instant death if drunk, but the bread made of the mass is of good taste and wholesome."[26] "When Columbus," says Herrera, "landed at Hayti, he was invited by the Cacique to go and eat *axi* and *cassabi*, which is their chief diet."[27] Hachi, it has been shown, is the Arrowack word for pepper, and the repast offered to Columbus was doubtless the hachi-duada or pepper-pot of the Arrowacks, with which cassava was always eaten. There was another custom of the Haytians which was evidently derived from South America. Their mode of sleeping was in hammocks, which is the general custom in that continent, but not at all found among the northern Indians, and the word *hamaka*, it has been seen, belongs to the Arrowack language.

Lastly, the Haytians believed that they were derived from the south. "They had a tradition," says Martyr, "that they came from Martinique; that they were compelled to leave it in consequence of dissensions and strifes in it, and, on their arrival at

[25] Martyr, Decade IV, Book I, Ch. 3 and 4.
[26] Herrera, Decade I, Book I.
[27] Herrera, Dec. I, Book I, Ch. 18.

Hayti, struck with its great size, called it *Quisqueia*, which in their language signifies exceedingly great; but afterwards gave it the name of Hayti, from the craggy mountains that were in it." Martinique was one of the chain of smaller islands inhabited by the Carribees, but which, as has been observed, they conquered from the Arrowacks. It was perhaps the invasion of them by the Carribees that produced the strifes and seditions in Martinique mentioned in the tradition as having caused the Arrowacks inhabiting it to remove to Hayti.

ART. XX.—*Abstract of a Meteorological Journal, kept at Marietta, Ohio:* latitude 39° 25′ N., and longitude 4° 28′ W. of Washington, for the year 1862; by S. P. HILDRETH, M.D.—[Thirty-fifth Annual Report.][1]

MONTHS.	THERMOMETER.			Fair days.	Cloudy days.	Rain & melted snow in inch. and thous'ths.	Prevailing winds.	BAROMETER.		
	Mean.	Maximum.	Minimum.					Maximum.	Minimum.	Range.
	°		°							
January, . .	35·53	67	13	6	25	6·673	N., N.W. & S.	29·85	28·95	0·90
February, . .	33·60	56	11	12	16	3·056	N., N.W. & S.E.	29·75	28·85	0·90
March, . .	41·27	75	16	11	20	5·392	N.W., S. & S.E.	29·55	28·65	0·90
April, . .	51·52	81	30	16	14	7·673	E.S.E. & N.	29·65	28 85	0·80
May, . . .	57·15	84	36	22	9	3·783	N., S. & S.E.	29·61	29·10	0·51
June, . . .	65·78	88	44	15	15	2·541	S., S.W. & N.	29·65	29·10	0·55
July, . . .	73·47	93	54	20	11	3·524	S., S.W. & N.	29·75	29·18	0·57
August, . .	73·17	93	46	20	11	3·641	S., S.E. & N.	29·68	29·25	0·43
September, .	68·40	94	38	25	5	0·285	S., S.W. & E.	29·78	29·10	0·68
October, . .	54·57	90	26	18	13	2·564	S., S.W. & N.	29·73	29·00	0·73
November, . .	41·07	69	24	17	13	2·053	S., S.E. & N.W.	29·90	29·00	0·90
December, . .	35·87	68	10	16	15	3·372	S., S.W. & N.W.	30·03	28·90	1·13
Mean,	52·62					42·557				

The mean temperature of the year 1862 is 52°·62. The amount of rain and melted snow is $42\frac{557}{1000}$ inches.

Remarks on the winter of 1862.—The mean of the winter months is 33°·33. February was the coldest of the series, being 33°·60. December was 37°·00, which is rather above the mean, some years falling as low as 21°·00, and others rising to 40°·00. January is usually a mild month compared with either December or February. The lowest grade of the mercury in January was 13°, on the fifth day. In February the lowest was 11°, on the 16th day. There was a large amount of rain in January, filling

[1] Dr. Hildreth's first Abstract of Meteorological Observations (for 1828) was published in the 16th volume of the 1st series of this Journal (1829). The series has been uninterrupted to the present time, and this is therefore the 35*th contribution*. By an inadvertence this enumeration was attached to the last abstract published in March, 1862, which error we take this mode of correcting. Our oldest readers will rejoice that the life of our venerable correspondent has been continued to complete another of his annual contributions.—EDS.

all the rivers to the tops of their banks. This excess of rain continued all through the middle and latter portion of the winter. The amount in January was 6·67 inches, and during the winter over 11 inches. The quantity of snow was small, compared with most winters, being only two inches at the greatest fall. Very little ice was formed in the rivers, and navigation remained open during all the winter months. No ice was gathered here but such as was brought from rivers north of us. The moisture of the air and mild temperature was very favorable to the ripening of the young wood of grape vines and fruit trees, especially of the peach, and an abundant crop of blossoms appeared in due season; but a frost, in the latter part of April, destroyed a great deal of the recently set fruit. The ill effects of a winter without hard freezing are seen more in the soil than elsewhere, the plow and the spade turning it up compact and heavy, instead of porous and loose as it is after ordinary winters, showing its effects on the soil during all the season. A very dry time in May or June partly restores that loose texture so necessary to the healthy growth of plants.

Remarks on the spring of 1862.—The mean temperature of the spring, was 53°·31,—which is a fair average for this season of the year. The mean of March was 41°·27; this month varies much; in some years rising to 52°, and in others sinking to 32°. The mean of April was 51°·52, not far from the average temperature. It varies greatly however, rising to 59° and falling to 42°, a difference of seventeen degrees. It is usually considered as indicating the mean for the year. The temperature for May is 57°·15, which is below the average, some years rising to 67° and then falling to 55°, making a diversity both pleasing and useful. The spring was very wet, there falling nearly fifteen inches of rain, about half of which was in April. In this month the larger portion of plowing is done by the farmers, for the summer crops. The earth in most fields was like mortar, and plowing in this condition was hurtful to cultivation. This excess of moisture caused the decay of a large portion of seed corn, requiring a second and sometimes a third planting. The fields in June afforded an unsightly and unpromising appearance. Pastures and meadow lands were benefited by the rains, but the grass and hay were much less nutritious than in common years, although the yield was abundant. The flowering of fruit trees was rather tardy, six or eight days behind the usual time. The healthy setting of the fruit is sometimes injured by heavy rains washing away the pollen of the flowers. This, I believe is more common to forest trees, especially the oak and black walnut, though these are rarely hurt by frosts. The spring fruits were abundant and ripened at the usual time, especially strawberries, new varieties of which are annually added to our abundant varieties. The spring of 1863 is the appointed season here for the ap-

pearance of that wonderful insect, the seventeen-year locust, or Cicada.[2]

Remarks on the summer of 1862.—The mean temperature of this season is 70°·80, which is one degree and a half below the average of a series of years. The month of June was cooler than usual, being only 65°·75, whereas it often rises to 70°, and sometimes to 74°, but this is a rare occurrence. July was 73°·47, also rather low. August was near the same, or 73°·17, being an abundant quantity of heat for perfecting the growth and ripening all the fruits and grain adapted to this climate. In July, the temperature sometimes rises to 76° for the whole month, but not often. The summer fruits ripened at the usual time, red cherries early in June, Catawissa raspberries by the twentieth, and early apples the first week of July. Many fields of wheat were ready for harvesting the 22d of June, but the main harvest began the 6th of July. The quality of the grain was excellent, but not so abundant as in some years. A new and more hardy variety, with a thicker covering to the seed, not so easily punctured by insects, has been introduced by the intelligent farmers of Ohio, and this important crop is becoming more certain than in past years. It is also less liable to rust in the hot and wet weather of the last of June, a disaster in some years of immense damage, destroying whole fields when nearly or quite ready for the sickle. The amount of rain in the summer months was but little over half of that in the spring. The effect was disastrous to crops of maize and potatoes, especially on the hills and uplands, these not yielding half the amount of ordinary years. Rich alluvions suffered but little. The prices of these important articles of food rose to double their common value. The season was favorable to sweet potatoes and to melons, which were abundant and of excellent quality. Among the insects injurious to vegetation, appeared a new one on our pear and quince trees, the larva of *Selandria Cerasi*, described by the late Professor Harris. It proved very hurtful, especially to young pear trees. It is the worst of all these pests, as it continues its ravages all summer, by fresh deposits of eggs by the parent Saco-fly. Other insects were less abundant than common.

Remarks on the autumn of 1862.—The mean temperature of the autumnal months is 54°·71, which is a full average for the climate. The month of October was very mild, some of the early days being of the warmth of summer, rising to 90° or more. The season was very dry, there being less than five inches of rain for the three months, whereas in some years September has as much rain as all of them in 1862. This drouth was very injurious to the late crops, especially buckwheat, which in many fields was an entire failure, and in all a very short crop. Late planted potatoes yielded very sparingly. Pasture grounds were much

[2] The *Cicada septemdecim* appeared at New Haven in June, 1860. See this Jour., xxxiii, 433.—*Eds.*

parched, and some neighborhoods suffered from the drying up of springs and wells. Corn had mostly attained maturity by the middle of September, and suffered less than several other articles. The crop of apples was generally good, especially certain varieties of winter fruit. Pears are but sparingly cultivated on account of "the blight," so certain to attack this tree, especially those of a vigorous growth and in rich soils. The best protection is a poor earth and elevated position, near the top of a hill, with a northerly exposure. This, in my opinion, proves the disease to arise from a profusion of sap and not from insects. The quince tree is liable to the same disease, but not to so injurious an extent, attacking only the extremities of the branches, and seldom fatal to the whole tree. The past year has been free from the terrible storms and tornadoes which sometimes visit us. In general terms, this year has been a favorable one to the farmer, as well as to the health of the people.

Floral calendar and ripening of fruits.—January 1st, Bluebird heard, and has been here all the winter.—March 6th, Robin appears; 7th, Bluebird singing; 9th, various birds heard; 17th, Blackbirds; 19th Wood larks and robins; 21st, Hepatica triloba in bloom, Dwarf Iris; 28th, Daffodil, white and blue Crocus.—April 2d, Hyacinth; 3d, Magnolia conspicua in full bloom: this beautiful exotic is in most years so early in putting out that the blossoms are destroyed by frost, before fully expanded; 4th, Peach in warm exposures; 5th, Japan quince and Golden bell; 7th, Peach in full bloom generally; 10th, Sanguinaria Canadensis; 12th, rose or pink colored Japan quince; 14th, Gooseberry; 15th, Crown imperial; 18th, Pear tree and white Spiræa prunifolia; 19th, June berry and Siberian crab apple, Maple tree in full foliage; 21st, Strawberry; 23d, Apple tree, Yellow root, Harebell; 26th, Ornithogalum, Chickasaw plum and Cherry; 29th, Birthwort; 30th, Tulips.—May 1st, Lilac, Quince tree; 4th, Purple tree Peony; 10th, Horse chestnut, black Haw; 11th, native Crab-apple tree; 14th, Lily of the valley; 15th, Snowball; 16th, purple Magnolia; 17th, Weigela rosea; 18th, yellow and white Calceolaria; 19th, Viburnum fruticosum; 20th, Locust tree, Iris tricolor; 22d, Syringa fragrans, yellow Harrison rose, Magnolia tripetala; 26th, Catawissa raspberry; 27th, new seedling Peonies, ten varieties; 30th, Syringa Philadelphica; 31st, Strawberry ripe.—June 4th, white Iris; 5th, Guernsey Lily; 8th, blight in Quince tree begins; 9th, Rose bugs in vast numbers in the country, destroying the young fruit of apple and peach; 11th, red Cherry ripe; 15th, white garden Lily open, slugs on Pear and Quince trees, making great destruction of the leaves; 17th, Kirtland Raspberry ripe; 19th, Magnolia glauca in bloom; 20th, Catawissa Raspberry ripe, Catalpa in bloom, Wheat harvest begins.—July 1st, Chandler Apple ripe; 4th, Dew-berry ripe; 11th, Blackberry ripe; 16th, American broom in blossom: 17th, Turk's-cap lily, Sweet-bough apple and Hale's early peach ripe.—August 13th, Muskmelon ripe; 14th, Blue plum; 15th, Hildreth, Seckle and butter pears ripe; 16th, Watermelons.—September 5th, Lychnis coronaria in bloom; 6th, Concord grape ripe; 7th, Delaware grape, second crop of Catawissa raspberry ripe; 10th, white Doyenne pear ripe; 12th, Rebecca grape; 16th, Herbemont grape ripe, Portugal quince ripe; 20th, Catawba grape.

Marietta, January 1st, 1863.

Art. XXI.—*Waterglass;* by John M. Ordway. Part IV.

[Continued from vol. xxxiii, p. 36.]

Its Precipitation by alkaline salts.

In specifying the properties of waterglass, Fuchs mentions that[1] "the salts with alkaline bases, especially carbonates[2] and chlorids, produce pasty precipitates in the glass solution;"—but neither he nor any subsequent writer has given an accurate account of the nature of these products. Some, confounding the precipitates thrown down by salts of potash or soda with those resulting from the action of ammonia salts, have supposed the deposits to be mere silica. Kuhlmann, on the other hand, confidently declares that common salt combines directly with silicate of soda, forming an insoluble compound. Biased by his assertion, and having indeed found a notable quantity of chlorid in a well drained precipitate, I temporarily disposed of the matter in Part II by saying[3] "the precipitate with chlorid of sodium in any case appears to be a double combination of silicate and chlorid." But appearances may deceive, and therefore an early opportunity was sought, to investigate the subject in earnest, and either establish or set aside the provisional statement.

A very few trials sufficed to show that, according as both the saline liquids and the waterglass solutions differ in kind, strength, and quantity, the deposits obtained by mixing vary greatly in amount and character, some being partially soluble in water and others entirely so. Of course then, it will not do to wash the precipitates, and no way can be devised of getting them absolutely free from adhering mother-liquor and, at the same time, leaving them otherwise unaltered. Hence, in every instance, the amount of each constituent of the solid product may be made up of two unknown quantities,—one expressing the portion belonging to the precipitate proper, and the other that due to the mother-liquor retained. Analysis gives the sum of the two portions of an ingredient, but the positive ratio of these parts to each other can be found neither by experiment nor by calculation. The only recourse is to a tentative method,—we must make successive assumptions and, following them out to their legitimate consequences, see which gives results squaring most completely with all the ascertainable facts. The following detailed examples will serve to illustrate the nature of the problem and the mode of its solution:—

[1] *Ueber ein neues nutzbares Produkt aus Kieselerde und Kali.*

[2] The normal carbonates, as will be seen by examples on the following pages, have no claims to preëminence as precipitants. It is possible that Fuchs had in mind the bicarbonates, which many chemists once regarded as normal.

[3] This Journal, [2], xxxii, 340.

1.—50 grams of a liquid containing 20 p. c. of $\dot{N}a_2\ddot{S}i_5$, mixed with 100 grams of a 20 p. c. chlorid of sodium solution, gave a copious precipitate which contracted greatly by standing 24 hours. The clear supernatant liquor being then decanted, the deposit was washed several times with cold water. Under this treatment, the product changed from a dense curd to a light flocculent matter, which, after drying in the air, weighed only 0·282 grms. It contained 0·224 grms. of silica.

2.—100 grams of the same chlorid of sodium solution having been stirred into 50 grams of the liquid waterglass, after 48 hours the contracted deposit was gathered in a cotton cloth and well squeezed by hand. It weighed 17·2 grams, and was not wholly soluble in water.

a.—Some of this solid matter by drying and ignition lost 55·8 p. c.

b.—Another portion was digested in water and treated with nitric acid in slight excess; then, after saturation with ammonia, the whole was dried down. The filtered solution of the residue, on being tested volumetrically with nitrate of silver, according to Mohr's method, indicated 5·05 p. c. of NaCl as such.

c.—A third quantity, by suitable treatment with water and chlorhydric acid, afforded 31·58 p. c. of SiO_3 and 20·95 parts of chlorid of sodium. Deducting from the latter the 5·05 p. c. of preëxisting NaCl, we have 15·9 parts of chlorid due to the soda and showing 8·23 p. c. of NaO.

By the same mode of examination, the mother-liquor was found to contain 14·09 p. c. of NaCl, 1·41 p. c. of SiO_3, and 0·55 p. c. of NaO; the latter two constituents being in such proportion as to make up $\dot{N}a\ddot{S}i_{1\cdot8}$[4].

3.—Again, 100 grams of the 20 p. c. chlorid of sodium solution, were mixed with 50 grams of 20 p. c. $\dot{N}a_2\ddot{S}i_5$. After a time the precipitate was collected in a cloth and subjected to the action of a powerful press. The solid, nearly transparent mass weighed 12·1 grams, and was wholly soluble in cold water.

The hard product by a controlled analysis gave 46·62 p. c. of SiO_3, 11·48 p. c. of NaO, and 0·67 p. c. of NaCl.

The mother liquor contained 13·97 p. c. of NaCl, 1·35 p. c. of SiO_3, and 0·59 p. c. of NaO. These numbers correspond to $\dot{N}a\ddot{S}i_{1\cdot5}$ in the supernatant liquid; but how shall we tell what silicate makes up the net coagulum?

In the first place, the utter absurdity of presuming on the identity of the well-washed precipitate with the same not subjected to the action of pure water is forcibly shown by comparison of the less than 0·3 grms. of light matter in No. 1 with the 17·2 grms. of dense curd in No. 2, or with the 12·1 grms. of hard pressed matter in No. 3.

Secondly, let us suppose the 55 p. c. of water in the squeezed deposit of No. 2 to be all owing to retained mother-liquor. Then,

[4] In reducing the composition to a uniform representation by empirical equivalents, it may be an improvement on the course adopted in Part III, to take one of base instead of one hundred, and let the acid come in decimals. Thus "$\dot{N}a\ddot{S}i_{1\cdot8}$" is more compact than "$\dot{N}a_{100}\ddot{S}i_{180}$."

since the fluid drained off contains 84 p. c. of water,—84 : 100 : : 55 : 65 p. c. of mother-liquor remaining in the moderately pressed curd. But in 65 parts of the liquid there should be 9 parts of chlorid of sodium, while the whole precipitate actually shows but 5 p. c. of NaCl. This hypothesis therefore has less than nothing to rest on, and falls to the ground.

Its ruins naturally suggest a third assumption, which is that all the chlorid of sodium found in the coagulum belongs to liquor not pressed out. According to such a conjecture, we have 14·09 : 100 : : 5·05 : 35·8 p. c. of mother-liquor contained in the solid product of No. 2, leaving 25 parts of combined water in the precipitate proper,—for the simply adhering fluid cannot differ in composition from the liquid squeezed out. When the amount of imbibed fluid is reduced to a practical minimum by strong pressure, as in No. 3, the chlorid of sodium almost disappears, and the just inference is that there would be none left, were the elimination of extraneous liquor absolute. Certainly, if the chlorid were thrown down in actual combinations, the drier the curd was pressed, the greater would be the percentage of salt in the residue.

Our third assumption proves correct to a moral certainty, by its exact accordance with all the observed facts in the preceding examples as well as in numerous other instances; and we may fairly conclude that the salts of potash and soda, like alcohol, precipitate from waterglass an uncombined silicate.

Having now the needed datum, we may proceed to deduce the true constitution of the product in No. 2. The mother-liquor in it has just been computed to make up 35·8 p. c., and that quantity of mother-liquor accounts for 0·19 p. c. of NaO and 0·5 p. c. of SiO_3. After deducting these amounts from the respective gross numbers furnished by analysis, we find, on carrying out the necessary calculations, that the net precipitate consists of 39 parts of $\dot{N}a\tilde{S}i_{2\cdot 65}$ and 25 parts of water.

So likewise in No. 3, the mother-liquor is reduced to 4·8 p. c., while 58 parts $\dot{N}a\tilde{S}i_{2\cdot 65}$ and 37 parts of water make up the precipitate proper. And since 58 : 37 : : 39 : 25, the products of No. 2 and No. 3 are, as they should be, alike in respect to combined water.

As the subject thus assumed a definite and prehensible form, other experiments were made on the same general plan, with various waterglass and saline solutions. The investigation required far more time and labor than was anticipated; and it may well be thought that more space is here allotted to the matter than waterglass of its own specific self deserves. But waterglass, by reason of its relation to what Graham calls the 'colloids,' has a family importance which entitles it to a still fuller study; for the peculiarities of this natural order of bodies constitute a missing link, or series of links, in the chain of chemical knowledge.

More trials have been fully carried out with chlorid of sodium as a precipitant than with any other salt, on account of the ease and precision with which chlorine may be determined. Many of the precipitates were simply squeezed by hand, because it was only after making considerable progress that I found out the advantage of resorting to mechanical aid,—No. 3, above, being in fact about the fortieth experiment. Among the following instances, the term 'hard pressed' refers to the effect of a screw multiplying the power 680 times, minus the loss by friction. For the sake of uniformity, the numbers have in each case been made to correspond to 100 grms. of waterglass solution though twice or one-half that quantity was sometimes actually used.

4.—100 grms. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$, with 200 grms. of 25 p. c. NaCl, gave a large precipitate, which was well washed with cold water. The ignited residue weighed only 3·22 grms.

5.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$, with 200 g. of 25 p. c. NaCl, yielded 47 g. of a squeezed precipitate wholly soluble in water and containing 34 p. c. of mother-liquor and 42·7 p. c. of $\dot{N}a\ddot{S}i_{2\cdot83}$.
In the mother-liquor there were 1·7 p. c. of $\dot{N}a\ddot{S}i_{1\cdot56}$.

6.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$, with 100 g. of 25 p. c. NaCl, gave 45·5 g. of a soluble product containing 31 p. c. of mother-liquor and 42·3 p. c. of $\dot{N}a\ddot{S}i_{2\cdot57}$.
In the mother-liquor there were 2·7 p. c. of $\dot{N}a\ddot{S}i_{1\cdot80}$.

7.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$, with 50 g. of 25 p. c. NaCl, gave 40·9 g. of a soluble curd containing 23 p. c. of mother-liquor and 45·9 p. c. of $\dot{N}a\ddot{S}i_{2\cdot75}$.
In the mother-liquor there were 4·8 p. c. of $\dot{N}a\ddot{S}i_{1\cdot82}$.

8.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$, with 25 g. of 25 p. c. NaCl, afforded 33·3 g. of a soluble precipitate containing 23 p. c. of mother-liquor and 42·5 p. c. of $\dot{N}a\ddot{S}i_{2\cdot69}$.
In the mother-liquor there were 10·7 p. c. of $\dot{N}a\ddot{S}i_{2\cdot15}$.

9.—100 g. of 10 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$, with 100 g. of 10 p. c. NaCl, gave 8·6 g. of an opaque precipitate not wholly soluble in water. It contained 57 p. c. of mother-liquor and 27·4 p. c. of $\dot{N}a\ddot{S}i_{3\cdot57}$.

10.—100 g. of 10 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$, with 50 g. of 10 p. c. NaCl, gave 2·2 g. of a hard pressed, opaque mass not wholly soluble in water and containing 49 p. c. of $\dot{N}a\ddot{S}i_{3\cdot51}$.

11.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot25}$, with 100 g. of 25 p. c. NaCl, gave 31·4 g. of a translucent, soluble curd containing 29 p. c. of mother-liquor and 42·5 p. c. of $\dot{N}a\ddot{S}i_{2\cdot51}$.
In the mother-liquor there were 6 p. c. of $\dot{N}a\ddot{S}i_{1\cdot84}$.

12.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot25}$, with 50 g. of 25 p. c. NaCl, gave 22·4 g. of a soluble precipitate containing 33 p. c. of mother-liquor and 38·8 p. c. of $\dot{N}a\ddot{S}i_{2\cdot52}$.
In the mother-liquor there were 12 p. c. of $\dot{N}a\ddot{S}i_{2\cdot10}$.

13.—100 g. of 10 p. c. $\dot{N}a\ddot{S}i_{2\cdot25}$, with 100 g. of 10 p. c. NaCl, yielded 1·15 g. of a partially soluble precipitate containing 30·8 p. c. $\dot{N}a\ddot{S}i_{3\cdot87}$.

14.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_2$, with 400 g. of 25 p. c. NaCl, gave 13·6 g. of a hard pressed, soluble product containing 7·7 p. c. of mother-liquor and 61·2 p. c. of $\dot{N}a\ddot{S}i_{2\cdot62}$.
The mother-liquor contained 12·3 p. c. of $\dot{N}a\ddot{S}i_{1\cdot50}$.

15.—100 g. of 25 p. c. $\dot{N}a\tilde{S}i_2$, with 200 g. of 25 p. c. NaCl, gave 11·3 g. of a soluble curd containing 10·7 p. c. of mother-liquor and 54·7 p. c. of $\dot{N}a\tilde{S}i_{2\cdot6}$.

The mother-liquor contained 6·3 p. c. of $\dot{N}a\tilde{S}i_{1\cdot8}$.

16.—100 g. of 25 p. c. $\dot{N}a\tilde{S}i_2$, with 100 g. of 25 p. c. NaCl, yielded 6·25 g. of a hard pressed mass containing 18 p. c. of mother-liquor and 50·3 p. c. of $\dot{N}a\tilde{S}i_{2\cdot5}$.

The mother-liquor contained 10·5 p. c. of $\dot{N}a\tilde{S}i_{1\cdot9}$.

17.—In several different trials, chlorid of sodium had little or no effect on sesquisilicate of soda.

18.—100 g. of 25 p. c. $\dot{K}\tilde{S}i_{2\cdot5}$, with 100 g. of 25 p. c. KCl, gave 21·2 g. of a hard pressed, soluble product containing 11·5 p. c. of mother-liquor and 59·6 p. c. of $\dot{K}\tilde{S}i_3$.

The mother-liquor contained 6·35 p. c. of $\dot{K}\tilde{S}i_2$.

Here we have a deposit of 12 6 g. of dry $\dot{K}\tilde{S}i_3$, while in 6,—the parallel soda experiment,—19·2 g. of dry $\dot{N}a\tilde{S}i_{2\cdot6}$ were thrown down. A potash silicate is therefore less precipitable than the corresponding soda waterglass.

The two following trials were made with reference to Berthollet's doctrine of the partition of bases among contending acids.

19.—100 g. of 25 p. c. $\dot{N}a\tilde{S}i_{2\cdot8}$,—containing 5·4 g. of soda,—were mixed with 50 g. of 25 p. c. KCl,—which would be equivalent to 7·9 g. of potash. The hard pressed product weighed 28 g., and, according to the mean of two determinations with bichlorid of platinum, contained 78 parts of potash to 54 parts of soda.

20.—Into 100 g. of 25 p. c. $\dot{N}a\tilde{S}i_{2\cdot5}$ were stirred 61 g. of 25 p. c. KCl mixed with 41 g. of 25 p. c. NaCl,—so that in the sum of the ingredients there might be 8 g. of sodium and 8 g. of potassium. The hard pressed precipitate weighed 35 g., and, tried by the method of Richter, showed nearly equal quantities of potassium and sodium.

Similar results were obtained in experiments made with silicate of potash and chlorid of sodium, or with a silicate of one alkali and an acetate of the other.

The alkaline acetates are rather more efficient than the chlorids, in throwing down waterglass. Owing to the alkaline reaction of the acetates themselves, it is not easy to analyze with accuracy the contaminated products, and the results given below, claim only an approximation to correctness. The potash or soda was determined by neutralization with a standard chlorhydric acid. The tested stuff being dried down with an excess of the same acid, the quantity of chlorid in the residue, minus the amount of chlorid due to the alkali of the silicate, indicated the percentage of acetate.

21.—100 g. of 25 p. c. $\dot{N}a\tilde{S}i_{2\cdot5}$, with 200 g. of 25 p. c. $\dot{N}aAc$, gave 39·4 g. of a hard pressed, soluble mass, containing 59 p. c. net of $\dot{N}a\tilde{S}i_{2\cdot60}$.

22.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot5}$, with 50 g. of 25 p. c. $\dot{N}a\bar{A}c$, gave 41·8 g. of a hard pressed product containing 53·4 p. c. net of $\dot{N}a\bar{S}i_{2\cdot64}$.
The mother-liquor contained 2 p. c. of $\dot{N}a\bar{S}i$.

23.—100 g. of 10 p. c. $\dot{N}a\bar{S}i_{2\cdot5}$, with 100 g. of 10 p. c. $\dot{N}a\bar{A}c$, gave 4·8 g. of a hard pressed, opaque mass, not wholly soluble in water, and containing 52 p. c. of $\dot{N}a\bar{S}i_{3\cdot70}$.

24.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_2$, with 100 g. of 25 p. c. $\dot{N}a\bar{A}c$, gave 36 g. of a hard pressed, soluble precipitate, containing 47 p. c. of $\dot{N}a\bar{S}i_{2\cdot56}$.

Acetate of soda gave very slight precipitates with sesquisilicate of soda, but only after standing some time.

25.—100 g. of 25 p. c. $\dot{K}\bar{S}i_{2\cdot5}$, with 100 g. of 30 p. c. $\dot{K}\bar{A}c$, gave 35·4 g. of a hard pressed, soluble mass, containing 61·4 p. c. net of $\dot{K}\bar{S}i_{2\cdot96}$.
The mother-liquor showed 1·2 p. c. $\dot{K}\bar{S}i$.

26.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot5}$, with 100 g. of 25 p. c. nitrate of soda, gave 26·5 g. of a hard pressed, soluble product, containing 24 p. c. of mother-liquor and 48·4 p. c. of $\dot{N}a\bar{S}i_{2\cdot9}$.
In the mother-liquor there were 6·4 p. c. of $\dot{N}a\bar{S}i_{2\cdot06}$.

Nitrate of soda had very little effect on the more alkaline silicates.

Sulphate of soda has still less precipitating power than the nitrate, as the following example sufficiently shows.

27.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot5}$, with 100 g. of 25 p. c. $\dot{N}a\bar{S}$, underwent no change. 100 g. more of the sulphate solution after a time gave 1·7 g. of a hard pressed, partially soluble precipitate containing 51·6 p. c. net of $\dot{N}a\bar{S}i_{3\cdot22}$.

28.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot5}$, with 100 g. of 25 p. c. hyposulphite of soda, gave 12·6 g. of a hard pressed, soluble precipitate, containing gross 43 p. c. $\dot{N}a\bar{S}i_3$.

29.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot5}$, with 100 g. of 25 p. c. tartrate of soda, gave 10·6 g. of a hard pressed, soluble curd containing gross 53 p. c. of $\dot{N}a\bar{S}i_3$.

30.—100 g. of 25 p. c. $\dot{K}\bar{S}i_{2\cdot5}$, with 100 g. of 25 p. c. $\dot{K}\bar{C}r$, gave 7 g. of a hard pressed precipitate not wholly soluble in water.

31.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot5}$ gave no precipitate with 100 g., with 200 g., or with 400 g. of 25 p. c. $\dot{N}a\bar{C}$.

And in other trials of the carbonate with the same and with more alkaline silicates, there was either no deposit at all or an exceedingly slight one appeared only after long standing. Normal carbonate of soda, therefore, is devoid of precipitating power.

When common arseniate of soda is mixed with a waterglass solution, no proper curd is formed at first, but the whole mixture soon becomes a very firm translucent jelly, which in the course of a few days breaks up into a thin liquor and a sort of coagulum capable of being pressed. Among many experiments made with 10 or 25 p. c. arseniate solutions and different silicates, the hard pressed product has in no case proved to be wholly soluble.

Indeed, the precipitates were always found to contain at least 4 equivalents of silica to 1 eq. of alkali. Thus,

32—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_2$, with 100 g. of 25 p. c. $\dot{N}a_2\ddot{A}s$, gave 35·3 g. of a hard pressed, opaque mass containing 44·4 p. c. net of $\dot{N}a\ddot{S}i_{5\cdot10}$.

The cause of this seemingly anomalous behavior on the part of the arseniate,—and the phosphate acts in the same way,—is to be found in the fact, long ago developed by Graham, that, in the so-called "neutral" arseniates and phosphates, only two-thirds of the proper quantity of alkali is present, and they are therefore in reality acid salts. Hence, when either of them is brought in contact with waterglass, it appropriates a considerable part of the alkali of that feeble combination, and of course gelatinizes the silica. Indeed, its action is similar to that of a bisulphate or a bicarbonate. It is observable that in making the mixture no change takes place till so much of the arseniate or phosphate is added as will seize on all the soda except somewhat less than is needed to form with the silica $\dot{N}a\ddot{S}i_3$. Thus,

33.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_2$, with 50 g. 25 p. c. $\dot{N}a_2\ddot{A}s$, suffered no visible alteration, though it was allowed to stand two days. And here $6\dot{N}a\ddot{S}i_2+2\dot{N}a_2\ddot{A}s=2\dot{N}a_3\ddot{A}s+4\dot{N}a\ddot{S}i_3$. But 25 g. more of the arseniate solution at once gelatinized the whole mass. $6\dot{N}a\ddot{S}i_2+3\dot{N}a_2\ddot{A}s=3\dot{N}a_3\ddot{A}s+3\dot{N}a\ddot{S}i_4$.

Of course then, to make experiments parallel to those carried on with chlorids, acetates, and the like, it was necessary to start anew and use the really neutral or normal $\dot{N}a_3\ddot{P}$ and $\dot{N}a_3\ddot{A}s$. These salts were found to have little or no effect on any waterglass.

34.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{2\cdot5}$ gave no precipitate with 100 g., or with 200 g. of 25 p. c. $NaO.BO_3$.

The following trials were made to ascertain the influence of temperature:

35, *a*.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_2$ were mixed with 100 g. of 25 p. c. NaCl,—both cooled to 0° C. There was no change. Warmed to 18° the mixture became turbid, and deposited 3·4 g. of a hard pressed mass containing 51 p. c. gross of $\dot{N}a\ddot{S}i_{2\cdot5}$.

a'.—The mother-liquor, heated in a water bath to 90° C., gave 16·8 g. of a hard pressed product containing 51·5 p. c. gross of $\dot{N}a\ddot{S}i_{2\cdot38}$.

b.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_2$ and 100 g. of 25 p. c. NaCl, both boiling hot, gave 21 g. of a hard pressed curd containing 50 p. c. gross of $\dot{N}a\ddot{S}i_{2\cdot38}$.

The mother-liquor remained clear on cooling.

36, *a*.—100 g. of 25 p. c. $\dot{N}a\ddot{S}i_{1\cdot75}$ were mixed with 100 g. of 25 p. c. $\dot{N}a\dot{A}c$,—both at the boiling point. The hard pressed precipitate, weighing 6·7 g., contained 47 p. c. gross of $\dot{N}a\ddot{S}i_{2\cdot43}$.

a'.—The mother-liquor cooled to 3° C. gave 6·1 g. of a soft deposit containing 44 p. c. gross of $\dot{N}a\ddot{S}i_{1\cdot93}$.

37, *a*.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot8}$, cooled to 6° C. were mixed with 100 g. of 25 p. c. $\dot{N}a\dot{N}$ cooled to 14°. The precipitate hard pressed, and after 48 hours again hard pressed, weighed 38·8 g., and contained 54 p. c. gross of $\dot{N}a\bar{S}i_3$.

a'.—92 g. of the mother-liquor, heated to 90° C., gave 1 g. of a curd containing 44 p. c. of $\dot{N}a\bar{S}i_{3\cdot4}$.

b.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot8}$ and 100 g. of 25 p. c. $\dot{N}a\dot{N}$, on being mixed at a boiling heat, gave 34 g. of a hard pressed, transparent, soluble mass containing 58 p. c. gross of $\dot{N}a\bar{S}i_{2\cdot92}$.
The mother-liquor cooled to 1° C. remained perfectly clear.

38, *a*.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot8}$ at 2° C. were mixed with 100 g. of 25 p. c. $\dot{N}a\bar{S}$. The precipitate contained 8·3 g. of $\dot{N}a\bar{S}i_{3\cdot36}$.

a'.—137 g. of the mother-liquor, heated to 90° C., gave a precipitate in which there were 1·56 g. of $\dot{N}a\bar{S}i_{3\cdot58}$.

b.—100 g. of 25 p. c. $\dot{N}a\bar{S}i_{2\cdot8}$ and 100 g. of 25 p. c. $\dot{N}a\bar{S}$ were heated to the boiling point and mixed. The hard pressed curd weighed 20·6 g., and contained 9·5 g. of $\dot{N}a\bar{S}i_{3\cdot52}$.
The mother-liquor remained clear on cooling.

These examples, selected from more than a hundred trials, serve to illustrate the following points:—

1. Many neutral potassium and sodium salts cause a precipitation in liquid waterglass; but the various salts are very unequal in precipitating power, the acetates and chlorids being particularly efficient.

2. The less alkaline the silicate is, the more matter is thrown down by a given saline liquid.

3. The more concentrated the solutions are, the more complete is the precipitation.

4. Heat increases the precipitating power of the chlorids, sulphates, and nitrates, and diminishes that of the acetates.

5. With strong liquors, an increase in the quantity of precipitant used is not attended by a proportionate increase in the amount of coagulum; but a little more of the saline liquid than will just produce a disturbance usually suffices to throw down the greater part of all that is precipitable.

6. The deposits have a greater or less tendency to cohere into a hard or pasty mass, and can therefore be in a great measure freed from adhering mother-liquor by strong pressure.

And it may be remarked, in passing, that the solid precipitates, obtained from waterglass by means of alcohol, are deprived of extraneous liquor more readily and completely by the press than by the slow process of absorption recommended in Part III.

7. When the products, thus forcibly cleared of foreign matter, are less siliceous than the tersilicates, they are wholly soluble in cold water. Exposed to the air for a day or two, in a warm place, they lose 20 p. c. or more of their weight, and become dry and hard,—the solubility remaining unimpaired.

8. The salt used as a precipitant, does not enter into the proper composition of the deposit; but the net precipitate consists of silica, alkali, and water united in no definite proportions.

9. Saline liquids, like alcohol, exert a slight parting force on the constituents of waterglass, the deposit being always more siliceous than the original silicate.

10. The more dilute the respective solutions are, before mixing, the less alkaline will the precipitate be.

11. Silicate of potash yields a smaller deposit than silicate of soda does under similar conditions.

12. When a silicate of one alkali is precipitated by a salt of the other, both bases enter into the composition of the solid product, and the relative proportion of potash and soda therein, is very nearly the same as in the average of the liquors mixed.

The method here adopted, for determining the net composition of an unwashed precipitate, might perhaps be found advantageous in many other cases in which pure water is likely to alter a deposited product,—and such cases are probably of more common occurrence than has been heretofore suspected. Of course when a mother-liquor would of itself contain no peculiar substance capable of showing, by the comparative quantity of it found in the drained precipitate, the amount of contaminating liquor, it would generally be easy to add some special indicator.

Decomposition of Waterglass by Water.

It is a question of no little interest, as well as of some practical importance, whether different solutions made from a given vitriform waterglass, will contain the same relative proportion of silica and alkali whatever be the quantity of water used in dissolving. Such an inquiry was first suggested by the finding of a notable disagreement in composition between a dense liquor turned out in the large way and a weak solution prepared in the laboratory, both from one and the same furnace charge of soda silicate. There was $\dot{N}a\ddot{S}i_{2\cdot3}$ in the stronger liquid, while the other contained $\dot{N}a\ddot{S}i_2$. The matter came up again in determining for a manufacturer how successful he had been in fluxing a mixture intended for bisilicate of soda. Some of the uniform product was at first sent for examination to a noted analytical chemist who reported that when 25 grains of the sample, reduced to fine powder and sifted, were boiled for four hours in 8 oz. of water,—4 oz. in first boiling and 4 oz. in the second,—the "precipitate and insoluble matter," washed, dried, and burnt, amounted to 13·2 p. c., and proved to be "pure silica and insoluble glass." This account was rather surprising and unsatisfactory, for the vitreous mass showed no sandy particles, and having been made from clean materials it could hardly contain any "insoluble glass." Pulverizing some of the same well vitrified silicate, I boiled 20

grams in about 150 c. c. of water for 30 minutes and obtained only 3·3 p. c. of residue. In view of so great a discrepancy, no one would suppose both determinations to have been correctly made. But finding by another trial that my own result was certainly not below the truth, I made the following experiments to ascertain whether the apparent error in the other case was the fault of the manipulator or of his method:—

1, *a*.—25 grams of the finely powdered glass were boiled briskly for one hour, in a copper vessel, with 100 c. c. of water,—a little water being added from time to time to make up for evaporation. The settled liquor being syphoned off, the sediment was boiled again for one hour with 100 c. c. of water as before. The whole deposit, well washed with cold water and dried at a red heat, weighed 0·28 grams, making 1·12 p. c.

1, *b*.—20 g. of the fine silicate were boiled with 200 c. c. of water for one hour. The undissolved matter was again boiled with 200 c. c. of water for one hour. The sediment after being washed and strongly heated, weighed 1·2535 g., making 6·27 p. c.

1, *c*.—15 g. of the sample were boiled for two hours with 1500 c. c. of water. The scaly deposit was boiled again one hour with 1500 c. c. of water. The washed and ignited residue, amounted to 2·13 g. or 14·2 p. c.

2, *a*.—400 g. of a very finely ground commercial silicate, containing 88 p. c. of $\dot{N}a\ddot{S}i_{2\cdot3}$, were boiled four hours in 1600 c. c. of water kept full. The sediment was boiled two hours with 1600 c. c. of water. A third boiling was maintained two hours. The final residue reckoned as free from water, made 9·24 p. c.

The first solution contained $\dot{N}a\ddot{S}i_{2\cdot2}$; the second $\dot{N}a\ddot{S}i_{1\cdot6}$; the third, $\dot{N}a\ddot{S}i_{1\cdot4}$.

2, *b*.—80 g. of the same glass were boiled four hours with 1600 c. c. of water. A second boiling lasted one hour, and a third was kept up three hours. The ignited residue amounted to 21 p. c.

2, *c*.—16 g. of the same powder were boiled four hours with 1600 c. c. of water, and again four hours with 1600 c. c. of water. The ignited residue amounted to 32 p. c.

2, *d*.—8 g. of the same product were boiled four hours with 8 litres of water in a kettle heated by steam,—the carbonic acid of gas flame being thereby avoided. The sediment was boiled again four hours. The ignited residue occupied one third more space than the original silicate. It amounted to 34·5 p. c.

This dehydrated matter contained nearly 97 p. c. of silica; that of *c*, 96 p. c.; that of *b*, 94 p. c.; that of *a*, 86·5 p. c.

3, *a*.—16 g. of a very pure and perfectly vitrified silicate,—$\dot{N}a\ddot{S}i_{1\cdot7}$,—of German manufacture, were boiled one hour with 80 c. c. of water.

The residue, after being boiled again, washed, and ignited, amounted to 0·44 p. c.

3, *b*.—15 g. after two boilings, with 1500 c. c. of water each time, left 8·7 p. c. of dry matter containing 94 p. c. of silica.

4, *a*.—20 g. of a remarkably nice commercial soda silicate, $\dot{N}a\ddot{S}i_{1\cdot54}$, were

boiled an hour with 80 c. c. of water. A second boiling was continued one hour. The ignited residue made only 0·93 p. c.

4, *b*.—10 g. of the same product were boiled one hour with 1000 c. c. of water. After another boiling the dry residue amounted to 1·73 p. c.

It seems then that, in boiling anhydrous waterglass the amount of matter left undissolved depends, in a great measure, on the quantity of water used. In other words, very siliceous waterglass is not integrally soluble in mere water, but dissolves without any considerable decomposition in a strong solution of the silicate itself. When the least practicable proportion of water is taken, the light flocculent deposits actually obtained are made up chiefly of earthy and metallic silicates; and it may be fairly inferred that in such cases an absolutely pure silicate of potash or soda would give no remainder except the very little produced by the first contact of pure water with the outer surface. But the sediment left after the action of a large quantity of water is dense and scaly, and under the microscope appears to consist of purely siliceous filmy skeletons of the original particles of the glass; and there would doubtless be such a residue even though the silicate were completely free from foreign matter. The greater the proportion of alkali, the less decomposable is fused waterglass; and we may safely say that pure products, a little more alkaline than the sesquisilicate, would dissolve without remainder in any quantity of water however great.

Recent applications of Waterglass.

A mere allusion was made in Part III to the admixture of waterglass with soap, because, of the different plans that had been proposed, some were palpably injudicious and others seemed to have been of so little avail that they had not come into continued use. The fault lay, not in the fundamental idea of such an application, but chiefly in the choice of the particular silicate to be used. Good soap is itself sufficiently alkaline, and any addition which increases its causticity, only injures its quality. To use anything so excessively alkaline as *liquor silicum*,—which is what the oldest propositions all direct,—is taking a long stride in the wrong direction. Gossage does better in recommending sesquisilicate of soda; but still this is too sharp, and certainly would not be mended by following his advice to dissolve it in caustic lye instead of water. Any plan for disposing of the soda in excess, by using the silicate liquor in the first or saponifying stage of the soap manufacture, involves a troublesome change in the well established routine of the process, and does not allow the elimination of impurities. The most feasible mode of introducing an addition is to put the given substance with the boiled and purified soap as it is run into the "frames" to cool, and mix the whole by the usual stirring or "crutching." But soap

makers who have tried the sesquisilicate on a large scale raise the objection that any considerable percentage of a thick solution will not combine with the soap to form a homogeneous mass. And consumers may consider it fortunate that it is at least difficult to cheapen soap with a substance in which the alkali is so imperfectly mollified.

The older schemes for making silicated soap must therefore be set down as useless or impracticable; but within the last two years it has been discovered that highly siliceous waterglass assimilates perfectly with soap, and decidedly improves its quality. And now a mild silicate, in the form of a thick liquid containing about thirty per cent of a compound ranging from $\dot{N}a\ddot{S}i_2{}_3$ to $\dot{N}a\ddot{S}i_2{}_5$, is manufactured very largely in New York and Boston, and has already come into general use among the soap makers in this country. It possesses the advantage over resin,—which, till the blockade of the Carolinas, has been the staple material for reducing the cost of common soap,—that it imparts neither color, nor smell, nor clamminess, however great may be the quantity used. Owing to the great difficulty of dissolving very siliceous waterglass, the so-called "soap liquid" costs more than the combination of resin and alkali does in ordinary times; yet it is cheap, and materially reduces the price of the product into which it enters. In fact, as a hard and good looking soap may be made, containing as much as sixty per cent of the fluid silicate, the manufacturer is under some temptation to exceed the proper limit and make 'waterglass in bars' instead of 'silicated soap.' It has never been definitely ascertained what proportions will best secure all the advantages to be derived from the silicate and still have the due amount of frothing power and softening influence, which are conferred only by the fatty acids. But it is certainly quite safe to incorporate twenty-five or thirty pounds of liquid waterglass with every hundred pounds of pure oleostearate of soda. The compound thus produced has greater detersive power than common soap, though the alkaline strength remains about the same, and the causticity is not sensibly increased. It is well known that water, except when it is very hot, splits up and only in part dissolves the alkaline stearates and margarates; and perhaps the principal reason why silicated soap works better than pure is that hydrated waterglass enters readily into complete solution, and tends to hinder the precipitation of the fatty bisalts.

(To be continued).

ART. XXII.—*On the Origin, Growth, Substructure and Chronology of the Florida Reef;* by Capt. E. B. HUNT, Corps of Engineers, U. S. A. (In a letter to Prof. A. D. BACHE, Sup't. U. S. Coast Survey.)

NEW HAVEN, CONN., Nov. 18, 1862.

SIR: The examination of the Florida reef, keys and mainland by Prof. Agassiz, in 1850–51 (Coast Survey Rept., 1851, Appendix No. 10), marks an era in our knowledge of the singular geological problems there exhibited, and especially of their zoological phases. This exploration, made under Coast Survey auspices, was amply justified by the fact that the Florida reef is the great American danger to navigation. One of the best aids in avoiding reef risks is a clear insight into the structure of the reefs and keys, and this can result only from scientific researches, aided by the Coast Survey detailed hydrography, now well advanced. The millions of property wrecked on the reef are in great part sacrificed to a needless ignorance of hydrography, reef structure, currents, winds and even of lights and beacons. Reef pilots are not employed, and ship masters are so poorly supplied with precise knowledge, of the kind needed for ensuring safe navigation amid these dangers, that many wrecks result solely from their ignorance. During the five seasons (1857–62) in which I was charged with the construction of Fort Taylor at Key West, I had good opportunities for knowing the history of the wrecks, occurring at the average rate of about one a week. I am now of the opinion that the loss of property in wrecks, which would be preventable by such accurate knowledge as can be furnished to navigators when the Coast Survey shall have published the complete reef hydrography and its full scientific discussions of reef structure, tides, currents and winds, has regularly exceeded the annual expense of the entire survey. Many shipmasters are incorrigibly ignorant, and many wrecks have, to my knowledge, occurred by masters not knowing new lights, which had been for many months conspicuously advertised in all the Custom Houses and in commercial papers. Would shipping merchants insist on having none but intelligent captains, and then furnish them with the very best information concerning the reef neighborhood, a large portion of the wrecks would be prevented. I think the study of currents and especially of *current variations*, in and near the Florida channel, is now particularly needed for preventing wrecks in this region. The fluctuations of currents from their supposed normal type certainly cause numerous disasters. The lack of distinct ideas as to the relations between the reefs and the keys, and ignorance of the mani-

fest signs of proximity to the reef, are the real causes of many disasters. The Coast Survey has done so much to disarm the reef of its terrors and to make known its true character, that, aside from my own connection with the Coast Survey organization, it seems appropriate for me to present to you some views on the origin, growth, substructure and chronology of the reef, which have resulted from my observations while at Fort Taylor, and which may prove a needful supplement to Prof. Agassiz's Report.

The grand curve of our Atlantic coast terminates in the remarkable crescent of keys and reefs which begins some miles north of Cape Florida and extends in a well defined curve some two hundred and forty statute miles to Tortugas Bank. At Cape Florida its axis is north and south. In moving down the reef, this direction revolves with the sun, until at Tortugas it bears about 5° north of west. This crescent consists of a line of keys and a parallel outer line of reefs, which are separated, on an average between five and six miles, by a navigable channel obstructed by coral heads. The reef terminates about opposite the Marquesas, some fifty miles east of Tortugas Bank. Between the line of keys and the mainland of Florida, is a body of shoal water, shaped much like a cornucopia, which embraces Key Biscayne Bay, Card's Sound, Barnes's Sound and the Bay of Florida. The line from Tortugas to Cape Roman, which may be taken as the mouth of this cornucopia, is one hundred and twenty miles long, the deepest water on it being twenty fathoms, and all within or east of it being still shoaler and characterized by singular evenness of bottom. The Straits of Florida, between the reef and the Cuban coast, are about a hundred miles wide, and the bottom slopes from the reef down to eight hundred fathoms just off the submerged cliffs of Cuba. The hundred fathom curve of the bottom is about seven miles out from Cape Florida, and from thence to Tortugas it gradually separates farther from the keys, being there over twenty miles out.

The well traced curve, along which this grand Florida Bank thrusts itself out into the deep waters of the Gulf, is strikingly significant of some continuous and regular agency in its production. The adjacent flow of the Gulf Stream would most naturally be assumed to govern in some way the production of this curve. It however runs in the wrong direction to serve this explanatory use, and it is in fact rarely found to run close in upon the reef. There is however an eddy counter-current intermitting in character and of variable rate, but on the whole a positive and prevailing current.[1] At Cape Florida it is narrow and precarious; but it widens as it sweeps to the westward, occasionally becoming over ten miles wide at Key West,

[1] See C. S. Rept., 1858, App. 32. This Journal, 1859, vol. xxvii, p. 206.

and twenty miles off Tortugas. It sometimes runs over two knots, and is a great help to vessels bound west, when their masters know the reef well enough to venture so near. There is much need of more precise observations to make out the characteristics of this current, but its existence and its intermitting and sometimes powerful set are facts attested by all who know these waters thoroughly.

After careful consideration, I am led to ascribe the peculiar shaping and growth of the Florida Bank, including the keys, reefs and substructure, mainly to the sweep of this eddy counter-current. Darwin, Dana and Agassiz have so fully stated the zoological and other ordinary elements of reef and key growth that I need only refer to their works for details.[2] Special circumstances however so far modify the structure of the Florida reef that it is not fully embraced in the principles laid down by these writers. It is not an *atoll*, a *fringing* reef, or a *barrier* reef, in the accepted sense of these designations, but it is a reef or bank, shooting out independently *by its end* into the deep Gulf waters. Such at least is the view to which I have been led by simply considering the existing agencies as actually working.

The reef proper is the main field of coral growth. This growth is not in one compact mass, but in diversified coral heads, or detached masses. The bold slope of the reef towards the Gulf Stream, to the proper depth of growing coral, which here does not exceed a hundred feet, and the broad top-surface of the reef-section are teeming with solid corals and shells. The branching corals grow wherever the violence of the sea does not prohibit, and where moving sand does not forbid a secure foundation for coral colonies.

In general, wherever there are solid surfaces free from sand and mud, and washed by warm, moving salt water, the ova of the coral-polyps, diffused throughout the reef waters, attach themselves and grow, to the limit of their capacity. Thus the stones of the Fort Taylor breakwater and foundations, palmetto piles, iron bars lost overboard, &c., have become coated with branching and solid corals, whose growth, between the date of immersion and that of diving up, gives a measure of coral increase. Throughout the sand-covered bottom between the reefs and keys, along the sand-faced South beach-slope towards the reef, and over the mud bottoms north of the keys, there are no living corals, except on such accidental bases as may occur and in the coral heads which have grown up on these bases. Thus coral masses are mainly produced where the action of storms are most

[2] The structure and Distribution of Coral Reefs, by Chas. Darwin, Naturalist of the Beagle Expedition (1832-36). On Coral Reefs and Islands, by Jas. D. Dana, Geologist U. S Ex. (1838-42) 1853, and in this Journal, 1851-2, vols. xi, xii, xiii and xiv. Agassiz's Rept., C. S. Rept., 1851, App. No. 10, and Atlantic Monthly, May and June, 1862.

violent, and they are constantly giving way before the assaults of the waves and the corrosions of the numerous and active boring shells. A coral mass once broken loose undergoes active attrition and disintegration into calcareous sand of varying fineness. This sand, and the accompanying detritus of shells and echinoderms, which abound intermixed with the living coral, are by degrees borne on by the waves towards the south beaches of the keys, where some of the sand is thrown up on the slope of the beach ridge. A coral mass or shell once cast loose is killed, and is henceforth untiringly triturated by the waves, until it escapes their action, or is reduced to impalpable powder. Every agitation of the sand by the waves pulverizes it yet further, and brings it nearer to the consistency of the white mud which so largely prevails on the Bank towards its northern side. There is thus constant coral and shell growth and as constant disintegration in progress. All this action however takes place in the limited range of depth of less than 100 feet, within which only can the reef building corals grow. To account for the vast underlying mass, between this limit of depth and the deep original sea floor, is a problem hitherto unsolved and one which I hope to elucidate.

The tidal currents set strongly across the reef and through the channels between the keys, the flood running to the north and the ebb to the south side of the key crescent. When storms occur, the agitation of the waves extends to the bottom, over the shallower portions of the grand Bank, and stirs up the sand violently. This causes the water to take up and maintain in mechanical suspension such finely comminuted particles as have too little sinking force rapidly to reach the bottom again. The finer the particles the longer will they remain suspended, and the very coarse grains will hardly be lifted from the bottom. Between the coarsest and finest are grains of all intermediate sizes, and whether they will be suspended or not depends on the violence of the storm, and their interval of suspension varies with their size and the violence of the waves. It results that, in all storms of much violence, the water over the Florida Bank becomes white with the bottom deposits. In long, severe northers or gales, the water becomes almost milk-white across the whole Bank. This "white water" is a familiar appearance, and is one of the sure signs of proximity to the reef. As storms subside, the white sand and mud are gradually thrown down, and the water clears, after a day or two, to its peculiarly delicate transparency.

During the "white water" periods, the flood tidal currents set the white water over the north side of the Bank into the Bay of Florida, where, by reason of the greater depth, the process of deposition goes on; and thus the floor of this bay has become

covered with white mud, and has been brought up with a singular evenness to the prevailing depths. The portion of the Bank north of the keys is mainly composed of this fine mud, and the north shores of the keys have long shallow mud slopes, some portions of which seem to be solidifying. The ebb tide carries the white water out towards the Gulf Stream, and it is recognized at times many miles outside the reef. Abreast the Tortugas, it is sometimes encountered over thirty miles out. The eddy counter-current, setting perhaps two knots per hour, transports this white water and its suspended detritus to the westward into deepening water, where it has opportunity to settle as it goes, and finally reaches bottom some miles west of its point of formation. Once on the bottom, in deep water, below the action of the waves, nothing can remove it. Thus we have, in actual operation, a perfect mechanism for triturating the coral and shell growths, and for transporting the comminuted products, by wave disturbance, tidal currents and the eddy currents, to the deep water farther west. These agencies being all unquestionably real and now active, I find no reason to doubt that they have been the secular causes at work extending the Florida Bank by its western extremity.

A careful examination of the bottoms, as shown on the several Coast Survey charts of the reef, affords signal confirmation of this view. The indications of white mud, white sand, coral and broken shells, over all the south frontage of the reef, halfway to Cuba, to the west around Tortugas and Tortugas Bank, and over the entire long slope by which the west end of the Florida Bank runs down into depths of one hundred fathoms, and of four hundred and sixty to the southwest, as also the bottoms over the Bay of Florida, and westward to the hundred fathom curve, are all consistently indicative that the material of the bottom thus brought to light was originally organic, and has been worn down and transported to its present bed by some agencies like those I have described. The entire lack of any bottoms in the slightest degree tinctured with Mississippi mud is a perfect refutation of the view presented by Prof. Jos. LeConte,[3] that the substructure of the reef, up to the depth where coral growth can begin, is a result of the deposition of Mississippi sediment carried across the Gulf by the Gulf current. I venture the assertion that these bottoms are inconsistent with any view which does not derive them from the living coral, to the east of their present localities. Should it be said that these bottoms only indicate the mere surface character of the sea-bed, it may be replied that the great mass of the Bank substructure, shooting out to the west into the Gulf, and rising above the Gulf bottom on both sides, as is amply shown by the 10, 20 and 100

[3] This Journal, 1857, vol. xxiii, p. 46.

fathom curves around the west end of the Bank, is unmistakeably a special formation subsequent to the general shaping of the Gulf bed. The actual causes now at work in producing coral and shell material, and in grinding and transporting it, must necessarily result in a building up from the bottom along the line of the eddy current to the westward.

Combine with this the fact that the most effective winds and waves, both of trade and hurricane origin, come in upon the reef from the S.E., and must therefore help to transport detritus to the westward and northwest. Moreover, the heavy waves which wear the front face of the reef must work some of the detritus down along the south slope, and must thus aid in forming the actual double slope in which the bottom expands towards the Cuban cliff coast. It is unlikely that the wave actions extend with appreciable effect below from fifty to a hundred feet, and detritus once placed below their extreme range becomes permanently fixed. It is to be observed that the very zone of coral growth is that of wave agitation, and that this must prevent the lodgment of sand and mud on the growing coral, as, after storms, the swell will always last here until the waters are cleared of white mud. This may perhaps be quite as effective a cause as increased pressure, in limiting the depth of coral growth to about the same range as that of wave actions.

A careful consideration of such facts as are now ascertained leads me to the supposition that the growth of the line of keys and the line of reefs is simultaneous by their western extremities. The reef now ends opposite the Marquesas, while the Quicksands, Rebecca and Isaac Shoals, the Tortugas keys and the Tortugas Bank indicate the extension of the line of keys beyond the line of reefs to the west. It is remarkable that the Tortugas keys are entirely without the solidification so prominent at Key West. Fort Jefferson, resting wholly on sand foundations, has settled in all its circuit, and in some portions it has gone down nearly a foot, showing that a deep sand bed has yielded thus much to compression.

In the sheltered waters among these keys, there is an active growth of branching corals, &c., on sand foundations, which are torn up by storms and tossed on the beaches by the waves, to such an extent as to afford the vast mass of concrete materials used in the masonry of Fort Jefferson. There are however no extended rock masses, and the great vitality of the corals is shown in an active renewal of growth on dead coral sprigs. It is my impression that the mass of materials forming Tortugas keys and banks has been transported westward by the eddy current, and north and northwest by the south and southeast storms and hurricane waves, from the reef abreast and east of Marquesas. The shaping of the bottom indicates this, and it is

apparent that a westward extension of the reef must be slowly taking place. It would thus appear that the keys, at least in their substructure, are rather results of the waste from the present line of reefs than an original and anterior reef growth. Concurring with this process is the growth of coral as now at Tortugas, and in such heads or masses as can find foundation on the sand slopes of the keys.

The solidification of the keys must be a slow and later process, and, some thousands of years hence, the sand masses of the Tortugas may assume an oolitic structure like that now seen at Key West. The calcareous marl, wherever found, seems to be preparing for solidification, and in a single instance of hard marl, from the eastern portion of Key West, I observed what could easily be fancied to be the circles of incipient oolitic segregation. The crystallization of the contained salt soon broke up this appearance, and I never again obtained it, though the confirmation of such an observation of oolite *ab ovo* would have great interest, in consideration of the vast masses of this rock in the earth's crust. That the finely comminuted white mud or marl solidifies into oolite, on Key West, is I think fully shown by the fossil traces of a peculiar vegetable scum which forms in the lagoons. This scum, as the lagoons dry up, forms a leathery sheet, which is by drying split into pieces, which roll up at the edges, sometimes with three or four turns. I have found these rolls fossilized and looking much like bones, but distinctly showing the spiral curling in the section. Most of the oolitic rock of Key West, on weathering its fractures, shows a series of thin parallel edges averaging perhaps a half inch apart, which being more resisting rise on the weathered fractures above the softer parts between. These harder layers seem very like fossil scum sheets, but they are found in stones much above the present ponds or lagoons where it is hard to conceive that they are due to this origin.

Whether a calcareous sand-heap wholly above the water can solidify into an oolite is a question hard to answer; but it is only by such agency that I can explain the solid mound, of nearly a mile in diameter, which forms the west part of Key West and is wholly composed of oolite. The summit of this mound is about fifteen feet above high water, and is believed to be the highest point on the whole line of keys. The gale of 1846 raised the water to within seven feet of the apex, and we can readily conceive that, before the reef barrier protected it, a hurricane might have carried up sand to over fifteen feet above ordinary high water.

The oolite, as shown in the wells of Key West, becomes coarser grained and softer in descending. It is so open that the water level of the wells, even in the heart of the key, or half a mile from the sea, fluctuates with the tides, following them at intervals

varying according to position, but averaging, as nearly as I could ascertain, about three hours. The whole rocky mass of Key West is of this oolite, there being on the weathered surfaces and occasionally in the mass a yellowish-brown crust, hard enough to receive a polish and usually less than a quarter of an inch thick. The granite foundations of Fort Taylor, located in water of eleven feet, or less, were laid on rock which was dressed to form beds, by the use of a diving bell. The submarine rock thus examined was much like the shore rock, except that the materials were coarser, rather less compact and more brecciated. Occasional shell and coral brecciated masses are found on shore, but such traces are quite rare. In removing the beach sand ridge which skirted the whole south shore, I found a limited stratum, about six inches thick and a few rods long, composed wholly of imperfectly comminuted pieces of small branching corals, averaging about an inch long and a third of an inch thick. Otherwise, this whole ridge, about ninety feet wide and from five to eight feet thick, above high water, was composed wholly of sand, much of which was somewhat blackened by vegetable loam from the ridge scrub growth. It is observable that this calcareous sand is scarcely at all blown about by the winds. Once packed, it resists the blasts of northers and hurricanes so completely, that at a few feet from the reverse slope of the beach ridge, we find only marl and rock. It presents a marked contrast in this respect with siliceous beach sands, which may, as in Provincetown, Cape Cod, build up hills a hundred feet high, or be carried for miles into the interior. When dry and freshly turned up, it blows freely, but it seems never to be moved by winds from the place where the sea deposits it. It is obvious that the sea is washing away the rock along the south side of Key West, while the north mud slope is being augmented. Several hundred feet of the original south beach rock have probably been cut away.

I am indebted to Mr. Chas. Howe, now Collector at Key West, for some account of an artesian well, which in 1839–40 he sunk to a total depth of one hundred and thirty feet, on Indian Key, about eighty miles northeast of Key West. To the depth of fifteen feet, the rock was moderately soft and uniform. It then began to be unsound, the drill occasionally going down three or four feet at once. At forty-five feet, a gravel bed of about five feet was found, below which the rock became harder and continued very solid, with a few interruptions of unsoundness, to ninety-one feet, when another gravel bed of several feet was struck which gave much trouble. Below this the rock became exceedingly hard, and was "tinged with yellow specks." This continued to 130 feet, with several interruptions by "breaking through," the drill once going down five feet at one jump. The water injected

to clear the hole brought up pieces the size of pigeons' eggs, but unfortunately the specimens are now lost. I suppose, from Mr. Howe's verbal account, that all this rock was purely calcareous, and that the very hard variety, which was taken to be quartz, was a compact limestone, such as Dana frequently found in the Pacific coral formations. The unsoundness would seem to be due to the interrupted nature of coral beds, whether *in situ* or formed of coral boulders and sand.

In general, the actual structure of the reef seems to result mainly from three grand activities:—1st, the ceaseless and persistent growth of coral animals and shells on every appropriate site, within their proper range of depth, temperature and water-supply, which growth, by secretion, separates the carbonate of lime from the mass of the ocean and gulf water; 2d, the untiring action of the winds, tides and currents (aided by boring shells), in breaking up, triturating, transporting and depositing the calcareous products of the zoological processes; 3d, solidification by time, pressure, segregation and possibly by chemical transformation. It is a complex problem to trace the precise operation of these agencies, as now at work, and from the present to pass back over the past until that time when the Florida Bank did not exist, and when the shore from Cape Sable to Fort Dallas was the open ocean-front of South Florida. It seems however not too audacious to say that the agencies now at work present a general type of operation which requires but unlimited time to realize results no less than the formation, not only of the line of keys and reefs, but of the immense substructure which rises from the great original plane of the gulf bed. This plane along the Cuban coast was over eight hundred fathoms deep, and it could hardly have been less than three hundred fathoms under the present Tortugas group.

The evidence that South Florida and the base of the Bank have recently undergone neither elevation nor depression, to any considerable extent, is quite convincing. There is a remarkable coincidence of general level along the crescent of keys, and no reliable evidence of vertical movement is found on any of them. Prof. Tuomey fancied he saw evidence of elevation through several feet at Key Vaccas.[4] Believing that he had mistaken boulders for masses *in situ*, I inquired of Assistant Hilgard, whose observations on the keys during his surveying labors have been extensive, and he replied that he has "never seen any coral beds raised *in situ* above the water. He paid some attention to the subject, and remembers those at Key Vaccas particularly, where he satisfied himself by using a crowbar that they were boulders bedded in sand." Prof. Agassiz and Prof. LeConte

[4] This Journal, 1851, vol. ii, p. 390.

report the same impression. During the growth of two hundred and forty miles of keys there has been then no observable change of level. There is a dead fringing reef forming the Punta, or west angle of the entrance to Havana, which seems to have been elevated some six feet, and this is the only case of recent elevation in this vicinity with which I am acquainted.

Prof. Tuomey and Prof. Agassiz fully identify the formations at Fort Dallas with the rocks of the keys. The former reports the descent from the Glades along the Miami river to tide water at six[5] to eight feet, and estimates the height of the ridge where cut by the Miami at twenty to thirty feet. Prof. Agassiz estimates the highest shore bluff in this vicinity as not above thirteen feet. The siliceous sand which caps the beach ridge around to Cape Sable was probably transported by the waves down the east coast. There seems ample reason to suppose that the crescent from Cape Sable, through the Mangrove swamp and Hunting Grounds to Fort Dallas, and thence north along the coast ridge, is an older reef curve, and that the Everglades and Lake Okeechobee were the interior flats, analogous to Key Biscayne Bay, Barnes Sound and the Bay of Florida.

The Everglades, which cover about four thousand square miles, have a substratum of coralline limestone of very rough and irregular surface, which is covered by sand, siliceous in part at least, and soft mud from three to ten feet deep, which covers all but a few points of the limestone and is overgrown with rank saw grass. The water overlying this mud is about three feet deep in dry seasons, and rises after rains from two to three feet. Lake Okeechobee is but a deeper extension of the Everglades, its depth averaging about twelve feet, and its area being nearly twelve hundred square miles The slight elevation of the Everglade region increases gradually to the north, and the Kissimee river, which empties into the north margin of Lake Okeechobee, has a southerly course of near a hundred miles, with a current of half a mile to three miles. There is thus a very gentle rise throughout the peninsula, and in the general slope sweeping the north margin of the Gulf and South Atlantic.

The existence of abundant fossil corals in the Tertiary limestone strata of two hundred to three hundred feet thick, spreading from the Mississippi river around to Cape Fear river in North Carolina, indicates an ancient coral origin.[6] Prof. Tuomey was led by these evidences to a special examination of the Florida Reef, from which he concluded that a continuous process of

[5] Assistant F. H. Gerdes, U. S. Coast Survey, found the surface of the water in the Everglades to be 6 ft. 2½ inches above low water-mark at Fort Dallas: see Coast Survey Report for 1849, p. 47.

[6] There are corals in the Tertiary of the coast, but no continuous reef-rock, we believe, warranting the above remark. The many muddy streams have been in the way of the extensive formation of coral reefs on these coasts, even when, as in the Tertiary, the temperature of the ocean favored it.—Eds.

coral growth through geologic ages may have produced this immense coral limestone area. He agrees with Mr. Conrad in calling the Tampa limestone Tertiary. In all this space of limestone strata, there is no point whose altitude approaches to equality with the depth of near a mile, found off the Cuban coast. The whole view of this subject leaves a strong impression that no great changes of level have occurred during the period of formation, not only of the present crescent of reef and keys, and the Cape Sable and Fort Dallas crescent, but even in the more ancient coral period, which produced the North Peninsula and the coral limestones of the great Gulf and Atlantic slope.

Confirmatory evidence is found in the Bahama, Salt key, Cuba and Yucatan reefs, which have attained great expansion with but slight evidence of disturbance. There are no indications of atoll formation by sinking; but Darwin (Appendix, p. 186) appeals only to elevation, and meets the fact of the singular coincidence of level over many disconnected banks of great area in the West Indies, by supposing that the elevated masses of the banks were uniformly washed away by the sea during their elevation. It is evident that the remarkable evenness of soundings over these banks is a measure of the depth to which the destroying action of the waves extends in their several localities. The enormous accumulations on the Florida side of the Gulf Stream make it quite rational to suppose that Salt Key Bank, for instance, may have resulted from a single nucleal peak, now worn away by the sea, which has afforded a basis for the growth of a fringing reef and for a wasting action by the waves, whence an outward expansion may have resulted, which, in the course of ages, has accumulated the larger portion of the great truncated cone, now rising from near four hundred fathoms. To what extent the type of action which I have supposed instrumental in producing the Florida Bank may be applied in the explanation of other cases of coral reef, I am not qualified to decide. It can hardly be supposed that such acute and philosophical minds as Darwin's and Dana's would fail to perceive and give proper weight to this familiar action of attrition, transportation, and deposition.[7] Dana is very explicit in stating it, and I must there-

[7] It is certainly hardly to be supposed, that Darwin or Dana should have overlooked the effects of "attrition, transportation, and deposition"—causes acting alike whether the material subjected to them be coral and shells, or granite and sandstone. Mr. Dana, in his Report on Coral Reefs and Islands, in fact, attributes the formation of the reef-rock, or the great mass of the reef, to the consolidation of the coral debris made by the triturating waves and distributed by the waves and currents. See pages 41, 42, 57, 62, 105 to 109, 115, 121, 149, (or in this Journal, [2] xi, 366, 367; xii, 32, 36, 330 to 334; xiii, 35, 40; xiv, 78, 79, 88.) where the effects of the triturating waves and distributing currents are particularly described, even to the formation of coral mud in the shallow waters among the reefs.

Speaking of the effects of the currents among the Feejee Islands, he remarks, p. 42 (this Journal, [2] xi, 367): "When the materials from both sources, the shore and the reef, are mingled, the proportion will necessarily depend on the proximity to the mouths of streams, the breadth of the inner waters or channels, and the direc-

fore suppose, that a satisfactory explanation of the growth of the Pacific coral islands demands vertical movements unlike any exhibited in the West Indies.

If the views now presented are correct, the chronology of the reef becomes stupendous. The most rapid instance of coral growth which I found on the breakwater and foundations of Fort Taylor was a Meandrina of about six inches radius, which was produced within twelve years, or the rate was a half inch per annum. Numerous specimens derived from stones or piles whose dates of immersion were known, and whose surfaces were so rapidly coated by vegetation and corallines that we can safely assume the coral colonies to have been planted soon after immersion, all indicate for the vicinity of Fort Taylor a general rate of growth less than the above. There is no obvious reason why this rate should not be identical with that on the reef proper, as the tidal currents supply ample moving water, and the temperature is much the same.

Bearing in mind that the living reef belt hardly averages a mile in width, and that this is much interrupted, while the shoal part of the Bank averages between fifteen and twenty miles broad, and that this is but a small part of the breadth of the base of this bank, on the original bottom, aside from the marl and sand contributed to the Bay of Florida, we are overwhelmed with the immense demand for time. We ought not to suppose less than three hundred fathoms of detritus built up on an average. Moreover, much of this calcareous material is likely to

tion and force of the currents. These tidal currents often have great strength, and are much modified and increased in force at certain places, or diminished in others, by the position of the reef with reference to the land. Sweeping on, they carry off the coral debris from some regions to others distant; and again they bear along only the shore detritus, and distribute it. It is thus seen that the same region may differ widely in its adjacent parts—may seemingly afford evidence in one place that there is no coral near, and in another no basaltic land, although either is within a few rods, or even close along side. The extent of the land in proportion to the reef will have an obvious effect upon the character of the channel or lagoon depositions. When the island stands, like Bacon's isles (Feejees), as a mere point of rock in a wide sea enclosed by a distant barrier, the streams of the land are small, and their detritus quite limited in amount. In such a case, the reef and the growing patches scattered over the lagoon, are the sources of nearly all the material that is accumulated upon the bottom."

Again, p. 57: "The reef-rock, wherever broken, shows a detritus origin," etc.

Again, p. 121 (this Journal, xiii, 40),—treating of the precautions necessary to determine correctly the rate of growth of reefs, he observes: "It is also necessary to examine into whatever has any bearing upon the marine or tidal currents of the region—their strength, velocity, direction, where they eddy, and where not, whether they flow over reefs that may afford debris, or not. All the debris of one plantation may sometimes be swept away by currents to contribute to other patches, so that one will enlarge at the expense of others; or, currents may carry the detritus into the channels or deeper waters around a coral patch, and leave little to aid the plantation itself in its increase and consolidation."

Again, when explaining the origin of the hard compact limestone, containing rarely a fossil, which constitutes so large a proportion of the reef-rock, he says:

have been more than once used by the coral animals, and some must have been swept into the ocean waters. Taking the living reef at one-twentieth the breadth of the total bank, the depth of the bank at three hundred fathoms, and the rate of growth at ½ inch per annum, we find, aside from the other elements of protraction, 864,000 years as the time for building the bank, when considered in cross section. Considering the growth as being by the west end from Cape Florida to Tortugas Bank, a great increase of time is still demanded, so that we can hardly, on these data, diminish the chronology of the growth of the present Florida Bank even to a million years. Appalling as this estimate of time for building appears, it seems impossible honestly to reduce it. If to this be added the time consumed in building the Cape Sable and Fort Dallas crescent, and again the inconceivable periods demanded in the growth of the main peninsula and the limestone strata of the grand slope of the Gulf and South Atlantic, the imagination is appalled, and can only rest on limitless infinities. We can indeed readily make an arithmetical approximation to this inconceivable total. The nature of coral reefs limits the growing portion to the outer reef line, and it is a liberal allowance if we suppose a zone of one mile broad regularly covered with growing surfaces. The solidified masses derived from this zone, wherever deposited, cannot possibly increase, in the whole, more rapidly than this zone can supply the materials. If we assume these masses at 250 feet thick on their northern margin in Alabama, and 1800 feet thick on the present southern boundary, we can safely assume an average thickness of 900 feet. The length of the general line of

"An explanation of this peculiarity is obvious on the principle already discussed—the action of a triturating sea," etc.

Mr. Dana even considers the question of the transportation of the detritus over the bottom of the adjoining ocean, a point so well illustrated by Captain Hunt. On page 154 (this Journal, xiv, 83), he remarks as follows: "It is an inquiry of some interest, whether, in an archipelago like the Paumotus, coral debris is not carried from the coral islands, and distributed over the bottom of the ocean; and whether limestones, thus originating, are not in process of formation. I venture no positive assertion on this subject, yet would express strong doubts. The fact that soundings off some basaltic islands, as we recede from the reef-growing depths, lose more and more in the proportion of coral sand, till we finally reach a bottom of earth, like the material of the island, bears against the hypothesis. This was found to be the case off Upolu, where the reefs are extensive." The doubts here expressed could not exist in a sea where the reef-islands were swept by a marine current as strong as that passing the Florida Keys; and this is the special fact which gives originality and great interest to the researches above detailed by Captain Hunt, whether the idea that the formation of the reef consisted in a gradual elongation from the eastward, without subsidence—a view also of great interest, and original—be correct or not.

It may be added here, that the possibility, not to say strong probability, of great changes of level during and following the Post-tertiary, in the region of the Mexican Gulf, as well as in the other transverse tropical seas of the globe, the Mediterranean and East Indian, is one among the many sources of doubt that complicate the problem of time connected with the Florida reef.—J. D. D.

average cross section of the growing front cannot be less than 250 to 300 miles, or at the minimum a horizontal formation of 250 times the growing zone can be assumed. Taking the rate as before at 24 years to the foot, we shall have for the total time $24 \times 250 \times 900$, on the data as stated; or, we find the total period of 5,400,000 years, as that required for the growth of the entire coral limestone formation of Florida. The rate of coral growth is nearly a rigid one, scarcely subject to fluctuation in any supposable period of time, and the limitation of growth to an outer reef of narrow section is also a necessity of organic habits. If then it be a fact that all the limestone mass now considered is of coral origin, the time of coral growth cannot be reduced below the result given above. It is likely to be much greater, as all the elements have been assumed on the side of a minimum chronology, and no allowance is made for growth by the west end instead of by the front.

The derivation of the substructure of the bank from coral growth makes the seemingly formidable chronology deduced by Prof. Agassiz shrink into insignificance. But is this vastness of time really incredible? Does its shock to our ideas militate against its reality? It is not the method of true philosophy to belittle nature to our ideal standards, but it is rather our duty to seek facts without bias or preconception. Looking thus squarely at the facts of the reef, in the aspect I have regarded them, the aggregate of time given seems really and truly insufficient. There are vast possibilities of error in such estimates, but are we not quite as likely to err through our preconceptions of limited chronology as by boldly submitting to the guidance of estimation from actual bases!

ART. XXIII.—*Catalogue of Mineral Localities in New Brunswick, Nova Scotia, and Newfoundland;* by O. C. MARSH, B.A., of the Sheffield Scientific School, Yale College.

THE following list of mineral localities in New Brunswick,[1] Nova Scotia, and Newfoundland, is the first covering all these regions that has been published. Although necessarily imperfect in many respects, it has been prepared with considerable care, and it is hoped that it may prove of some service to mineralogists who are not familiar with these interesting regions.

The lists of minerals occurring at many of the places mentioned in the Catalogue, especially those in the trap district of the Bay of Fundy, are copied from the writer's notes, which were

[1] Many of the notices of localities referred to in this Province are given on the authority of Mr. Mathew, which is a sufficient guarantee for their general accuracy.

taken at the localities during several excursions to the Provinces, the first in 1854. Even these lists may, in some cases, be found incomplete; since the destructive tides of that region are constantly changing the outlines of the coast, and thus exhausting the old localities, while at the same time bringing to light others, equally rich in mineral treasures.

The notices of localities which the writer has not visited are derived from the best sources of information to which he had access. A few were taken from the publications of Jackson and Alger, Dawson, and Jukes, which contain much that is valuable in regard to the mineralogy of these Provinces.[2] The writer is also especially indebted to George F. Mathew, Esq., and Charles F. Hartt, Esq., of St. John, for important information in regard to localities, especially in New Brunswick, and to Prof. Forrest Shepherd, of New Haven, for notices of several new localities in Newfoundland.

There is probably no part of the world, except the trap district of India, which is richer in zeolites than the shores of the bay of Fundy; yet the minerals from that region have hitherto received but little attention in comparison with those from other similar sections, and hence no little confusion exists in regard to what species occur at the different localities. In the following lists of minerals from Nova Scotia, thomsonite, prehnite, and one or two other species are marked doubtful. The first is generally believed to be one of the most common minerals in that Province, yet on examining and analyzing specimens of the so-called thomsonite from many of its reputed localities, the writer found them to be invariably mesolite or natrolite,—most generally the former; and it is doubtful if this species has yet been discovered in that region. Prehnite, also, is stated to occur at two places on the bay of Fundy;[3] yet an examination of specimens, so considered, which were collected by the discoverers of the localities, as well as a careful exploration of nearly all the places in that section at which this mineral might naturally be expected to occur, has led the writer to believe that prehnite has not hitherto been met with in Nova Scotia, and that its existence at any locality in that Province is extremely doubtful.

The entire group of zeolitic minerals from the bay of Fundy is well worthy of careful study. The writer has for several years been collecting materials for a full examination of the different species, and hopes at some future time to embody the results of his investigations in a Monograph on the subject.

[2] Remarks on the Mineralogy and Geology of Nova Scotia, by Charles T. Jackson and Francis Alger; Memoirs of the American Academy, vol. i, 1833; Acadian Geology, by J. W. Dawson, F.G.S., Edinburgh, 1855; Geological Survey of Newfoundland, by J. B. Jukes, F.G.S., London, 1843.

[3] Near Black Rock, Kings Co., and at Clark's Head, Cumberland Co.

The following catalogue is arranged according to the plan used in Dana's Mineralogy. Only localities which afford cabinet specimens are in general included. The names of those minerals which can be obtained in good specimens at the several localities are printed in italics. When the specimens are remarkably good, an exclamation mark (!) is added, or two of these marks (!!) if the specimens are quite unique.

NEW BRUNSWICK.

ALBERT CO. GRINDSTONE POINT and ISLAND.—Barytes, iron pyrites, lignite.

HOPEWELL.—Gypsum (alabaster and selenite); Albert mines,—coal (albertite).

PALLET RIVER—fifteen miles from mouth,—coal.

SHEPODY MOUNTAIN.—Alunite in clay, calcite, iron pyrites, *manganite?* psilomelane, *pyrolusite.*

TURTLE CREEK.—Coal.

CARLETON CO. WOODSTOCK.—Copper pyrites (mined), hematite, limonite, wad.

CHARLOTTE CO. BEAVER HARBOR.—Chlorite, jasper.

CAMPOBELLO—at Welchpool.—Blende, copper pyrites, erubescite, galena, iron pyrites; at head of Harbor de Lute, galena (4 inch vein); at Head Harbor, copperas, iron pyrites.

DEER ISLAND—on west side.—Calcite (in amygdaloid), magnetite, quartz crystals.

DIGDIGUASH RIVER.—On west side of entrance, *calcite!* (in conglomerate), chalcedony; at Rolling Dam, graphite.

GRANDMANAN.—Between Northern Head and Dark Harbor, agate, amethyst, *apophyllite, calcite,* hematite, heulandite, jasper, magnetite, natrolite, *stilbite,* thomsonite?; at Whale Cove, *calcite!,* heulandite, laumontite, stilbite, *semi-opal!;* at Fish Head, two miles east of Eel Brook, chlorite in quartz (abundant); at Rosses' Island, quartz crystals; at White Head, chlorite, quartz crystals.

L'ETANG ISLAND Harbor.—Chlorite, iron pyrites, marble, serpentine; at La Téte, copper pyrites, erubescite, galena.

WAGAGUADAVIC RIVER.—At entrance, azurite, copper pyrites in veins, malachite; one eighth of a mile east, galena.

NEW RIVER.—At Mills, actinolite? (in porphyry).

SEELY'S COVE.—Hill, half a mile north, calcite, iron pyrites, magnetite, quartz crystals.

ST. STEPHEN.—Four miles north of, graphite in slate, molybdenite in gneiss, quartz crystals; at Mill Farm, iron pyrites.

WAUWIG RIVER.—Three miles up, at Cormick's Mills, pyrites in boulders, garnet, feldspar crystals, tourmaline; at Bartlett's Pond, quartz crystals.

GLOUCESTER CO. BATHURST.—Coal, malachite.

TÉTE-A-GOUCHE RIVER.—Eight miles from Bathurst, copper pyrites (mined), *oxyd of manganese!!* formerly mined.

KENT CO. Buctouche River.—Coal.
Cocaigne River.—On branch three miles from bridge, coal.
Richibucto River.—Three miles above Ford's Mills, and at Big Brook, coal; at Bassk, iron pyrites; Liverpool, limonite.
Kouchibouguasis River.—Coal.
KINGS CO. Belleisle Bay.—On north shore, galena in limestone, hornstone, jasper; Bull Moose Hill, large bed of magnetite on farm of Northrup and Benson.
Clifton.—Chlorite, epidote, hematite, orthoclase in crystals, prehnite, quartz crystals.
Hammond River.—At Sherwood's, graphite in limestone.
Hampton.—At Darling's Lake, agate, carnelian, jasper.
Kingston.—On ridge south of village, chlorite, magnetite, magnetic pyrites.
Nerapis.—Near Hatfield's Mill, pyrites; near Mather's Inn, amethyst, feldspar, quartz crystals.
Quispamsis.—Copper pyrites, galena, iron pyrites, laumontite.
Sussex.—Near Cloat's Mills, on road to Belleisle, argentiferous galena; one mile north of Baxter's Inn, *specular iron* in crystals, limonite; on Capt. McCready's farm, east of Church, *selenite!!* (crystals containing sand).
Upham.—Salt springs; four miles east of Titus' Mills, gypsum.
NORTHUMBERLAND CO. Boistown.—Coal; also at New Castle and Chatham.
QUEENS CO. Grand Lake.—At Long Point, barytes, copperas, and pyrites in fossil trees; Salmon River, on Crawford's farm, coal, copperas, pyrites, limonite; New Castle River, coal mines; Coal Creek, coal (formerly worked).
Long Reach.—Opposite VanWarts, chlorite.
Washedemoak River.—Two and a half miles from Long's Creek, coal; a few miles above mouth of W. River, on S.E. side of small cove, carnelian, chalcedony, hornstone, jasper, quartz crystals.
RESTIGOUCHE CO. Belledune Point.—*Calcite! serpentine, verde antique marble.*
Dalhousie.—Agate, carnelian.
Point LeNim.—Coal.
SAINT JOHN CO. Black River.—On coast, calcite, chlorite, copper pyrites, *hematite!* in crystals, pyroxene (green earth), quartz crystals.
Brandy Brook.—Epidote, *hornblende*, quartz crystals.
Carleton.—Near Falls, calcite (red).
Chance Harbor.—*Calcite* (deep red) in quartz veins, chlorite in argillaceous and talcose slate.
Little Dipper Harbor.—On west side, in greenstone, amethyst, barytes, quartz crystals.
Moosepath.—Feldspar (red), hornblende, muscovite, black tourmaline.
Musquash.—On East side Harbor, copperas, graphite, pyrites; at Shannon's, chrysotile, serpentine; East side of Musquash, *quartz crystals!* (in conglomerate).
Portland.—At the Falls, large bed of graphite (impure); at Fort Howe Hill, *calcite* (fine crystals in several forms), graphite; Crow's Nest,

asbestus, calcite (fibrous), *chrysotile*, magnetite, *serpentine*, steatite; Lily Lake, white augite?, chrysotile, graphite, serpentine, steatite, talc; How's Road, two miles out, epidote (in syenite), steatite in limestone, *tremolite;* Drury's Cove, graphite, pyrites, pyrallolite? indurated talc.

QUACO.—At Light House Point, large bed of oxyd of manganese; west of Point, lignite; east of Quaco, at Fuller's Creek, graphite, iron pyrites; farther eastward, asbestus, chrysolite, black tourmaline.

RED HEAD.—Calcite (fibrous), red jasper.

SHELDON'S POINT.—Actinolite, asbestus, calcite, epidote, (pistacite and zoisite,) malachite, specular iron.

CAPE SPENCER.—Asbestus, calcite, chlorite, specular iron (in crystals).

TEN MILE CREEK.—Coal (in slate and sandstone).

WESTBEACH.—At east end, on Evans' Farm, chlorite, talc, *quartz crystals;* half a mile west, chlorite, copper pyrites, magnesite (vein), magnetite.

POINT WOLF and SALMON RIVER.—Asbestus, chlorite, chrysocolla, copper pyrites, erubescite, pyrites.

SUNBURY CO. ORMOCTO RIVER.—Ten miles up north branch, coal.

LINCOIN.—Bog iron ore (abundant), wad.

VICTORIA CO. TABIQUE RIVER.—*Agate, carnelian*, jasper; at mouth, south side, galena; at mouth of Wapskanegan, gypsum, salt spring; three miles above, stalactites (abundant).

QUISABIS RIVER.—Blue phosphate of iron, in clay.

WESTMORELAND CO. BELLEVUE.—Iron pyrites.

DORCESTER.—On Taylor's Farm, cannel coal, clay iron stone; on Ayres' Farm, asphaltum, petroleum spring.

GRAND ANCE.—Apatite, selenite (in large crystals).

MEMRAMCOOK.—Coal (albertite).

SHEDIAC.—Four miles up Scadoue River, coal.

YORK CO. NASHWAAK RIVER.—Coal; Jay Creek, coal.

POKIOCK RIVER.—Stibnite? *tin pyrites*, in granite, (rare); Harvey Settlement, wad.[4]

NOVA SCOTIA.

ANNAPOLIS CO. CHUTE'S COVE.—*Apophyllite*, natrolite.

GATES' MOUNTAIN.—Analcime, magnetite, *mesolite! natrolite*, stilbite, thomsonite?[5]

HADLEY'S MOUNTAIN.—Chlorophæite, heulandite.

MARGARETVILLE.—Epistilbite?[6] laumontite, (colored green by copper), stilbite.

MARTIAL'S COVE.—*Analcime!* (inclosing native copper), chabazite, *heulandite.*

[4] See note on Antimony (Stibnite) in New Brunswick in the preceding number of this Journal, p. 150.

[5] See Introduction, page 211.

[6] A mineral from this locality has been described as *epistilbite* by Prof. How, of Kings College, Nova Scotia; but, in a recent communication to the writer, that gentleman expresses a doubt whether it may not prove to be heulandite on further examination. The crystalline form of the mineral could not be ascertained from the specimen analyzed. O. C. M.

Moose River.—Beds of magnetite.

Nictau River.—At the Falls, bed of hematite.

Paradise River.—Black tourmaline, *smoky quartz!!* (perfect crystals, more than one hundred pounds in weight, have been found in the soil).

Port George.—Faröelite, laumontite, mesolite, stilbite; east of Port George, on coast, apophyllite containing gyrolite.

Peter's Point.—West side of Stonock's Brook, *apophyllite!*, calcite, heulandite, *laumontite!* (abundant), native copper, stilbite.

St. Croix Cove.—Chabazite, heulandite.

Wilmot.—At the Spring, copperas.

COLCHESTER CO. Five Islands.—East River, *barytes!*, calcite, dolomite (ankerite), hematite, copper pyrites; Indian Point, malachite, magnetite, red copper, tetrahedrite; Pinnacle Islands, *analcime*, calcite, *chabazite!*, natrolite, siliceous sinter.

Londonderry.—On branch of Great Village River, *barytes*, ankerite, hematite, limonite, magnetite; Cook's Brook, ankerite, hematite; Martin's Brook, hematite, limonite; eastward of Great Village River, on high ground, hematite, limonite; at Folly River, below Falls, ankerite, iron pyrites; on high land, east of river, ankerite, hematite, limonite; on Archibald's land, ankerite, *barytes*, hematite.

Salmon River.—South branch of, coal, copper pyrites, hematite.

Shubenacadie River.—Anhydrite, calcite, *barytes*, hematite, oxyd of manganese; at the Canal, iron pyrites.

Stewiacke River.—Barytes (in limestone).

CUMBERLAND CO. Cape Chiegnecto.—Barytes.

Cape D'Or.—*Analcime*, *apophyllite!!* (large crystals, highly modified), chabazite, faröelite, laumontite, *mesolite*, malachite, *natrolite*, *native copper*, obsidian, red copper (rare), vivianite (rare); Horse-shoe Cove, east side of Cape D'Or, analcime, calcite, stilbite.

Isle Haute.—South side, analcime, *apophyllite!!*, albin?,[7] calcite, *heulandite!!*, natrolite, mesolite, *stilbite!*

Joggins.—Coal, hematite, limonite; malachite and tetrahedrite at Seaman's Brook.

Parrsborough.—Augite, amianthus, calcite, gypsum, hematite, iron pyrites, magnetite, quartz.

Partridge Island.—Analcime, *apophyllite!* (rare), *amethyst!* agate, apatite (rare), *calcite!!* (abundant in large and highly modified crystals), chabazite (acadiolite), chalcedony, cat's-eye (rare), gypsum, hematite, *heulandite!*, magnetite, *stilbite!!* (very abundant).

Clark's Head.—Analcime, anhydrite, chlorite, calcite, hematite, prehnite?, tremolite.

Swan's Creek.—West side, near the Point, calcite, gypsum, *heulandite*, iron pyrites; east side, at Wasson's Bluff and vicinity, *analcime!!* (occasionally enclosing native copper and malachite), *apophyllite!* (rare), *calcite*, *chabazite!!* (white, wine-yellow, and red (acadiolite) in large and very perfect crystals), gypsum, *heulandite!!*, malachite, *natrolite!*, native copper, red copper (rare), siliceous sinter.

[7] Specimens of the mineral, from this locality, which has for many years passed under the name of *albin*, have recently been examined by the writer, and proved to be merely a variety of calcite. o. c. m.

Two Islands.—Moss agate, analcime, calcite, chabazite, *heulandite.*
McKay's Head.—Analcime, calcite, heulandite, *siliceous sinter!*
Stronix Brook.—Laumontite.

DIGBY CO. Brier Island.—Native copper, in trap.
Digby Neck.—Sandy Cove and vicinity, *agate, amethyst, calcite, chabazite, hematite!* (in perfect crystals), *laumontite* (abundant), magnetite, *stilbite*, quartz crystals.
Gulliver's Hole.—*Magnetite, stilbite!*
Mink Cove.—Amethyst, *chabazite!* (crystals an inch in diameter), quartz crystals.
Nichol's Mountain.—South side, *amethyst, magnetite!* (in large and perfect crystals).
Trout Cove.—Six miles east of Sandy Cove, *agate, chalcedony.*
William's Brook.—Near source, *chabazite* (green), heulandite, stilbite, quartz crystals.

GUYSBORO' CO. Cape Canseau.—*Andalusite*, abundant in mica and clay slate.
Guysboro'.—Galena, hematite.

HALIFAX CO. Gay's River.—Galena, in limestone.
Halifax.—Southwest of, garnet, staurotide, tourmaline.
Tangier.—*Gold!* (occasionally crystalized) in quartz veins in clay slate, associated with auriferous pyrites, galena, hematite, mispickel, and magnetite.[8] Gold has also been found in the same formation, accompanied by iron pyrites and mispickel, at Country Harbor, Fort Clarence, Isaac's Harbor, Indian Harbor, Laidlow's Farm, Lawrencetown, Sherbrooke, Salmon River, and Wine Cove.

HANTS CO. Cheverie.—Oxyd of manganese (in limestone).
Petite River.—Gypsum, oxyd of manganese.
Windsor.—Calcite, cryptomorphite (boronatrocalcite?), glauber salt, hayesine. The last three minerals are found in beds of gypsum.[9]

INVERNESS CO. Mabon Harbor.—*Fluor spar!* (green).

KINGS CO. Black Rock.—Centrallassite, cerinite, cyanolite;[10] a few miles east of Black Rock, prehnite?, *stilbite!*
Cape Blomidon.—On the coast between the Cape and Cape Split, the following minerals occur in many places: some of the best localities are nearly opposite Cape Sharp,—*analcime!!*, *agate, amethyst!*, *apophyllite!*, calcite, chalcedony, chabazite, gmelinite (ledererite), faröelite, hematite, *heulandite!*, laumontite, magnetite, malachite, *mesolite*, native copper, (rare), *natrolite!*, psilomelane, *stilbite!*, thomsonite?, *quartz.*
Cornwallis.—At the Bridge, oxyd of manganese.
Hall's Harbor.—Analcime, *heulandite*, laumontite, *stilbite.*
North Mountains.—Amethyst, bloodstone (rare), *ferruginous quartz*, *mesolite* (in soil).
Long Point.—Five miles west of Black Rock, *heulandite, laumontite!!*, *stilbite!!*
Scot's Bay.—*Agate*, amethyst, *chalcedony*, mesolite, natrolite.

[8] This Journal, [2], xxxii, 395, 1861. [9] This Journal, [2], xxiv, 230, and xxxii, 8.
[10] Ed. New Phil. Jour., x, 84.

WOODWORTH'S COVE.—A few miles west of Scot's Bay, *agate!*, *chalcedony!*, *jasper.*

LUNENBURG CO. CHESTER.—Gold River, gold in quartz, iron pyrites, mispickel.

CAPE LA HAVE.—*Iron pyrites!*

THE "OVENS."—*Gold*, on the beach and in quartz veins, iron pyrites, *mispickel!*

PETITE RIVER.—Gold, in slate.

PICTOU CO. PICTOU.—*Jet*, oxyd of manganese, limonite; at Roder's Hill, six miles west of Pictou, barytes; on Carribou River, gray copper and malachite in lignite; at Albion Mines, coal, limonite; East River, limonite.

QUEENS CO. WESTFIELD.—Gold in quartz, iron pyrites, mispickel.

FIVE RIVERS.—Near Big Fall, gold in quartz, pyrites, mispickel, limonite.

RICHMOND CO. PLAISTER COVE.—West of, barytes and calcite in sandstone; nearer the Cove, calcite, *fluor spar* (blue), chalybite.

SHELBURNE CO. SHELBURNE.—Near mouth of Harbor, garnets (in gneiss); near the town, rose quartz; at Jordan and Sable River, *staurotide* (abundant in clay and mica slates), schiller spar.

SYDNEY CO.—Hills east of Lochaber Lake, iron and copper pyrites, chalybite, hematite.

MORRISTOWN.—Epidote in trap, gypsum.

YARMOUTH CO. CREAM POT.—Above Cranberry Hill, gold in quartz, pyrites.

CAT ROCK.—Fouchu Point, asbestus, calcite.

NEWFOUNDLAND.

ANTONY'S ISLAND.—*Iron pyrites*, in large cubical crystals.

CAPE BONAVISTA.—Copper pyrites, in quartz veins.

CATALINA HARBOR.—On the shore, *iron pyrites!* large and perfect crystals, in slate.

CHALKY HILL.—Feldspar, in crystals.

COPPER ISLAND, one of the Wadham group.—Copper pyrites (abundant).

CODROY'S ISLAND.—Gypsum, granular and fibrous.

GREAT CODROY RIVER.—On left bank, near mouth, gypsum, (abundant); seven miles inland, bituminous coal.

CONCEPTION BAY.—On the shore south of Brigus, erubescite and gray copper, in trap.

GREAT WHITE BAY.—Gold Cove, copper pyrites, in quartz veins.

GRAND POND.—Northeast of, bituminous coal, cannel coal.

HALL'S BAY.—In the bank of a river flowing into the bay, copper pyrites in quartz veins, traversing chlorite slate; at the head of the tide on the same river, shell marl, a bed twenty feet in thickness.

HUMBER RIVER.—Near mouth, marble (abundant), muscovite.

BAY OF ISLANDS.—Southern shore, *iron pyrites*, in slate.

LAWN.—Argentiferous galena, horn silver, ruby silver, silver glance.

PLACENTIA BAY.—At La Manche, two miles eastward of Little Southern Harbor, *galena!* very pure and abundant, in a vein of pink calcite traversing metamorphic slate. This vein is now worked, and 1400 tons of galena have recently been taken from it. On the opposite side of

the isthmus from Placentia Bay, barytes (flesh-colored), in a large vein, occasionally accompanied by copper pyrites.

Port au Port.—On the Isthmus, native copper, in trap.

St. George's Bay.—Galena in limestone; at Crabb's River, bituminous coal, (vein three feet in thickness), gypsum in bank of a brook, salt springs.

Shoal Bay.—South of St. Johns, copper pyrites.

Tor Bay.—Four miles from St. Johns, a chalybeate spring, noted for its medicinal properties.

Trinity Bay.—Western extremity, barytes (flesh-colored), a large vein.

Harbor Great St. Lawrence.—West side, fluor spar, galena.

Sheffield Labratory, Yale College, Sept. 10, 1862.

ART. XXIV.—*On the Correction of the Elements of the Orbit of a Comet;* by JAMES C. WATSON, M.A., Professor of Physics in the University of Michigan.

When a new comet has been discovered, its orbit may be determined approximately from three observations made immediately after its discovery. If the intervals between the observations are nearly equal, the method of Olbers may be applied, but if the intervals are considerably unequal, a nearer approximation may be made by the method of Legendre. When the approximate elements have been found, and it is required to find a system of parabolic elements which will best satisfy all the observations available, the following method will be found very convenient in practice, and will invariably give satisfactory results.

Let t, t', t'', be the times of observation, corrected for the time of aberration and reduced to the same meridian; λ, λ', λ'', the geocentric longitudes, and β, β', β'', the geocentric latitudes of the comet at the date of the first, second and third observations respectively. The observations must be corrected for parallax and reduced to the mean equinox of a fixed epoch, which is usually taken at the beginning of the year. Let us also denote by R, R′, R″, the distances of the earth from the sun, and by $\odot$, $\odot'$, $\odot''$, the longitudes of the sun, for the dates of the observations respectively.

The coördinates of the first place of the earth, referred to the third, are:

$$x = R''\cos\odot'' - R\cos\odot,$$
$$y = R''\sin\odot'' - R\sin\odot.$$

If we represent by g the chord of the earth's orbit between the places corresponding to the first and third observations, and by G the longitude of the first place of the earth as seen from the third, we shall have

$$x = g\cos G,$$
$$y = g\sin G;$$

and consequently,

$$\begin{aligned} R''\cos(\odot''-\odot) - R &= g\cos(G-\odot), \\ R''\sin(\odot''-\odot) &= g\sin(G-\odot). \end{aligned} \qquad (1)$$

The coördinates of the first place of the comet referred to the third place of the earth are:

$$\begin{aligned} x_1 &= \Delta \cos\beta \cos\lambda + g \cos \mathrm{G}, \\ y_1 &= \Delta \cos\beta \sin\lambda + g \sin \mathrm{G}, \\ z_1 &= \Delta \sin\beta, \end{aligned}$$

where Δ is the distance of the comet from the earth at the first observation.

Let us now put

$$\begin{aligned} x_1 &= \mathrm{D} \cos \mathrm{B} \cos \mathrm{L}, \\ y_1 &= \mathrm{D} \cos \mathrm{B} \sin \mathrm{L}, \\ z_1 &= \mathrm{D} \sin \mathrm{B}, \end{aligned}$$

and we shall have

$$\begin{aligned} \mathrm{D} \cos \mathrm{B} \cos(\mathrm{L}-\mathrm{G}) &= \Delta \cos\beta \cos(\lambda - \mathrm{G}) + g, \\ \mathrm{D} \cos \mathrm{B} \sin(\mathrm{L}-\mathrm{G}) &= \Delta \cos\beta \sin(\lambda - \mathrm{G}), \\ \mathrm{D} \sin \mathrm{B} &= \Delta \sin\beta. \end{aligned} \qquad (2)$$

If we represent by φ the angle at the third place of the earth between the first and third places of the comet, we obtain

$$\cos\varphi = \cos \mathrm{B} \cos\beta'' \cos(\lambda'' - \mathrm{L}) + \sin \mathrm{B} \sin\beta''.$$

Let us now put

$$\begin{aligned} n \sin m &= \sin\beta'', \\ n \cos m &= \cos\beta'' \cos(\lambda'' - \mathrm{L}), \end{aligned} \qquad (3)$$

and we shall have

$$\cos\varphi = n \cos(\mathrm{B} - m). \qquad (4)$$

Let κ be the chord of the orbit of the comet between the first and third places, and we get

$$\kappa^2 = \mathrm{D}^2 + \Delta''^2 - 2\mathrm{D}\Delta'' \cos\varphi,$$

or

$$\kappa^2 = (\Delta'' - \mathrm{D}\cos\varphi)^2 + \mathrm{D}^2 \sin^2\varphi, \qquad (5)$$

where Δ'' is the distance of the comet from the earth corresponding to the third observation.

If ψ and ψ'' represent the angles at the earth between the sun and comet at the first and third observations respectively, we shall have

$$\begin{aligned} \cos\psi &= \cos\beta \cos(\lambda - \odot), \\ \cos\psi'' &= \cos\beta'' \cos(\lambda'' - \odot''). \end{aligned} \qquad (6)$$

Then, if we denote by r and r'' the distances of the comet from the sun, at the times t and t'', we obtain

$$\begin{aligned} r^2 &= (\Delta - \mathrm{R}\cos\psi)^2 + \mathrm{R}^2 \sin^2\psi, \\ r''^2 &= (\Delta'' - \mathrm{R}''\cos\psi'')^2 + \mathrm{R}''^2 \sin^2\psi''. \end{aligned} \qquad (7)$$

Let us now put

$$\begin{aligned} \mathrm{D}\sin\varphi &= \mathrm{A}, & \mathrm{D}\cos\varphi &= a, \\ \mathrm{R}\sin\psi &= \mathrm{C}, & \mathrm{R}\cos\psi &= c, \\ \mathrm{R}''\sin\psi'' &= \mathrm{C}'', & \mathrm{R}''\cos\psi'' &= c'', \end{aligned}$$

and equations (5) and (7) become

$$\begin{aligned} \kappa &= \sqrt{(\Delta'' - a)^2 + \mathrm{A}^2}, \\ r &= \sqrt{(\Delta - c)^2 + \mathrm{C}^2}, \\ r'' &= \sqrt{(\Delta'' - c'')^2 + \mathrm{C}''^2}. \end{aligned} \qquad (8)$$

These equations (8) together with Lambert's equation,

$$(r+r''+x)^{\frac{3}{2}}-(r+r''-x)^{\frac{3}{2}}=\mathrm{M}(t''-t), \qquad (9)$$

where log. M= 9·0137327, will enable us to determine Δ'' by successive approximations, when the value of Δ is given.

We may therefore assume a value of Δ by means of the approximate elements of the orbit, and then find the value of Δ'' for which the corresponding values of r'' and x will satisfy equation (9). It will be observed that the value of Δ'' must be found by trial; and, if we assume also an approximate value of Δ'', we may find r'' from the last of equations (8) and then determine x from equation (9). Then we obtain a second value of Δ'' from the equation

$$\Delta''=a+\sqrt{x^2-\mathrm{A}^2}.$$

With the value of Δ'' thus obtained we recompute r'' and x as before, and in a similar manner find a still nearer approximation to Δ''. A few trials will generally give the correct result.

When Δ'' has thus been determined we find the heliocentric places of the comet by the following:

$$\begin{aligned} \Delta\cos\beta\cos(\lambda-\odot)-\mathrm{R}&=r\cos b\cos(l-\odot),\\ \Delta\cos\beta\sin(\lambda-\odot)&=r\cos b\sin(l-\odot),\\ \Delta\sin\beta&=r\sin b, \end{aligned} \qquad (10)$$

$$\begin{aligned} \Delta''\cos\beta''\cos(\lambda''-\odot'')-\mathrm{R}''&=r''\cos b''\cos(l''-\odot''),\\ \Delta''\cos\beta''\sin(\lambda''-\odot'')&=r''\cos b''\sin(l''-\odot''),\\ \Delta''\sin\beta''&=r''\sin b'', \end{aligned} \qquad (11)$$

where b, b'', and l, l'', are respectively the heliocentric latitudes and longitudes of the comet at the times t and t''. The values of r and r'' should agree with those obtained from equations (8).

The elements of the orbit are then found from the heliocentric places by means of the well known formulæ. For the node and inclination, we have

$$\begin{aligned} \operatorname{tang} i\sin(\tfrac{1}{2}(l+l'')-\Omega)&=\frac{\pm\sin(b''+b)}{2\cos\frac{1}{2}(l''-l)}\sec b\sec b'',\\ \operatorname{tang} i\cos(\tfrac{1}{2}(l+l'')-\Omega)&=\frac{\pm\sin(b''-b)}{2\sin\frac{1}{2}(l''-l)}\sec b\sec b'', \end{aligned} \qquad (12)$$

the upper sign being used when the motion is direct and the lower sign when the motion is retrograde, corresponding respectively to the cases where $l''>l$ and $l''<l$. In these equations, Ω denotes the longitude of the ascending node, and i the inclination of the plane of the orbit to the ecliptic.

The longitudes in the orbit are given by the equations:

$$\begin{aligned} \operatorname{tang}(\theta-\Omega)&=\operatorname{tang}(l-\Omega)\sec i,\\ \operatorname{tang}(\theta''-\Omega)&=\operatorname{tang}(l''-\Omega)\sec i, \end{aligned} \qquad (13)$$

where θ and θ'' are the longitudes in the orbit.

As a check on the accuracy of the computation we have

$$x^2=\{r-r''\cos(\theta''-\theta)\}^2+r''^2\sin^2(\theta''-\theta).$$

For the longitude and distance of the perihelion we put

$$\text{tang}\,(45°+\omega)=\sqrt[4]{\frac{r''}{r}},$$

and then we shall have

$$\frac{1}{\sqrt{q}}\sin F=\frac{\text{tang}\,2\omega}{\sin\frac{1}{4}(\theta''-\theta)\sqrt[4]{rr''}},$$
$$\frac{1}{\sqrt{q}}\cos F=\frac{\sec 2\omega}{\cos\frac{1}{4}(\theta''-\theta)\sqrt[4]{rr''}}, \qquad (14)$$

where $2F=\frac{1}{2}(\theta+\theta'')-\pi$, q denoting the perihelion distance, and π the longitude of the perihelion.

Let v and v'' be the true anomalies at the times t and t'', and we have

$v=\theta-\pi$,	$v''=\theta''-\pi$,	for direct motion, and
$v=\pi-\theta$,	$v''=\pi-\theta''$,	for retrogade motion.

Then for the time of perihelion passage T, we have

$$T=t\pm\frac{q^{\frac{3}{2}}\sqrt{2}}{75k}(25\,\text{tang}^3\tfrac{1}{2}v+75\,\text{tang}\tfrac{1}{2}v), \qquad (15)$$

which should agree with the value of T found by using the values of t'', v'', instead of t and v,

$$\log\frac{\sqrt{2}}{75k}=0{\cdot}0398723.$$

The preceding formulæ are all that are required for finding the elements of the orbit from two observations, when one of the geocentric distances is given. To solve the problem proposed, we assume, in the first place, an approximate value of Δ, and compute the elements of the orbit from the first and third observations, by means of these formulæ. With the elements thus obtained we compute the place of the comet for the time t', and compare it with the corresponding observation, and if we denote the computed longitude and latitude by λ'_0, and β'_0 respectively, we shall have

$$\lambda'+u'=\lambda'_0, \text{ and } \beta'+w'=\beta'_0,$$

where u' and w' are the differences between computation and observation. Next, assume a second value of the distance of the comet from the earth at the time t, which we represent by $\Delta+\delta\Delta$, and compute the corresponding system of elements, and we shall have as before

$$\lambda'+u''=\lambda'_0, \text{ and } \beta'+w''=\beta'_0.$$

We also compute a third system of elements from $\Delta-\delta\Delta$, ($\delta\Delta$ being the same as before,) and denote the differences between computation and observation by u and w, then we shall have[1]

$$u=f(\Delta-\delta\Delta),\ u'=f(\Delta),\ u''=f(\Delta+\delta\Delta),$$

[1] The assumed values of $\Delta-\delta\Delta$, Δ, and $\Delta+\delta\Delta$, should be so taken that the correct value of Δ—viz, that for which the differences u and w are a minimum—shall be within the limits $\Delta-\delta\Delta$ and $\Delta+\delta\Delta$, which may always be effected.

and similarly for w, w', and w''. If these three numbers are exactly represented by the expression

$$\alpha+\beta\left(\frac{x}{\delta\Delta}\right)+\gamma\left(\frac{x}{\delta\Delta}\right)^2,$$

where $\Delta+x$ is the general value of the argument;—since the values of u, u', and u'' will be such that the third differences may be neglected, this formula may be assumed to express exactly any value of the function corresponding to a value of the argument not differing much from Δ, or between the limits $x=-\delta\Delta$ and $x=+\delta\Delta$.

To find the coefficients α, β, and γ, we have[1]

Argument.	Function.	1st diff.	2d diff.	x	Function.	1st diff.	2d diff.
$\Delta-\delta\Delta$	$f(\Delta-\delta\Delta)$	$f'(\Delta-\frac{1}{2}\delta\Delta)$	$f''(\Delta)$	$-\delta\Delta$	$\alpha-\beta+\gamma$	$\beta-\gamma$	2γ
Δ	$f(\Delta)$			0	α	$\beta+\gamma$	
$\Delta+\delta\Delta$	$f(\Delta+\delta\Delta)$	$f'(\Delta+\frac{1}{2}\delta\Delta)$		$+\delta\Delta$	$\alpha+\beta+\gamma$		

whence by comparison we find

$$\alpha=f(\Delta);\ \beta=\tfrac{1}{2}\left\{f'(\Delta-\tfrac{1}{2}\delta\Delta)+f'(\Delta+\tfrac{1}{2}\delta\Delta)\right\};\ \text{and}\ \gamma=\tfrac{1}{2}f''(\Delta).$$

Now in order that the middle place may be exactly represented in longitude, we shall have

$$\gamma\left(\frac{x}{\delta\Delta}\right)^2+\beta\left(\frac{x}{\delta\Delta}\right)+\alpha=0,$$

from which we find

$$\frac{x}{\delta\Delta}=-\frac{1}{2\gamma}\left(\beta-\sqrt{\beta^2-4\alpha\gamma}\right)=p, \qquad (16)$$

or

$$x-p.\delta\Delta=0. \qquad (17)$$

In the same manner, the condition that the middle place shall be exactly represented in latitude gives

$$x-p'.\delta\Delta=0. \qquad (18)$$

In order that the orbit shall exactly represent the middle place, it requires that both conditions shall be satisfied simultaneously, but it will rarely, if ever, happen, that this can be effected, and we must therefore find the most probable value of x from the equations (17) and (18); viz., that for which the sum of the squares of the residuals shall be a minimum. Having thus determined the most probable value of x, we compute a final system of elements, with the geocentric distance $\Delta+x$ corresponding to the time t.

The application of these formulæ is not limited to the case of three observations. With an approximate value of Δ we may compute the elements from the extreme observations, and compare any number of intervening places, each of which will furnish two equations of condition for the determination of x. Should it be found that the residuals resulting from the final elements exceed the limits of the probable errors of the observations, the orbit cannot be a parabola, and it will be necessary to determine the excentricity.

Ann Arbor, Mich., December, 1862.

[1] The coefficient β should not be confounded with the latitude β previously used.

ART. XXV.—*Geographical Notices.* No. XIX.

PHYSICAL GEOGRAPHY OF THE REPORT ON THE MISSISSIPPI RIVER, BY HUMPHREYS AND ABBOT.

THE report of Captain Humphreys and Lieut. Abbot of the Corps of Topographical Engineers of the United States Army, on the "Physics and Hydraulics of the Mississippi River," has already been noticed in this Journal, in an article which gave a conspectus of the entire work.[1] The universal interest now felt in everything which illustrates the Physical Geography of the United States, the importance of this elaborate survey of the most characteristic region of our country, and the difficulty of obtaining copies of so costly a volume lead us to refer again to some of the statements which are made by the authors.

The immediate occasion of this work, as the reader will remember, was an act of Congress directing a scientific survey of the Mississippi Delta, including such investigations as might tend to determine the most practicable plan for securing it from inundation, and the best modes of deepening the channels at the mouths of the river. The report, consequently, is chiefly devoted to the Physics and Hydraulics of the river, that is to say, to the laws of velocity and volume, and the possibility of so controlling the current, as to protect the regions adjacent to the delta from destructive floods, and so as to maintain the facilities of navigation in the channels near the gulf. But the topography and hydrography of the entire basin of the Mississippi, including all its various tributaries, are likewise elaborately discussed. It is to this portion of the report, the Physical Geography, that we now call attention. Our object will be to condense within a limited space, some of the geographical facts which the volume contains, so that those who cannot consult the work itself may turn here for such information. In doing this we shall confine ourselves, without comment, to the statements of the authors, generally employing their own language. We regret that the limit of this article compels us to omit some of the interesting details which their scientific zeal and thoroughness have brought together.

Regarding the true Mississippi river as beginning at the confluence of the Upper Mississippi and the Missouri, eight of its tributaries are so important as to be distinguished from all the rest. In the order of the magnitude of their basins, these are the Missouri, Ohio, Upper Mississippi, Arkansas, Red, White, Yazoo and St. Francis. They are described in the order of their geographical position, first the right bank and then the

[1] [2], xxxiii, 181.

left, beginning with the southernmost, as follows: Red, Arkansas, White, St. Francis, Missouri, Upper Mississippi, Ohio and Yazoo.

1. *Red river Basin.*[2]—Few regions so limited in area, say the authors, are so diversified in character as this basin. While it includes only 97,000 square miles, large tracts of rich alluvion, a range of primitive mountains, numerous lakes, a rolling prairie, and a salt-desert tract are found within its borders. Capt. Marcy, U. S. A., first explored the sources of Red river in 1852. The general course of the stream is thus delineated in his report.

The Red river rises in the eastern rim of the vast desert plain known as *el Llano Estacado* at an elevation of about 2,500 feet above the sea. After flowing through a narrow ravine, some sixty miles in length, the river passes to the south of the Witchita Mts., the highest peak of which, Mt. Scott, is 1135 feet above its base. Beyond this, to the east, the river traverses "the cross timbers," an extensive belt of woodlands, which extend, between twenty and thirty miles in width, from the Arkansas river to the Brazos, some 400 miles. Still farther east, the celebrated Red river raft, an accumulation of drift logs, about thirteen miles long, obstructs the course of the stream. Below this, the river traverses a fertile and populous region, the character of which is well known.

The width of the Red river between its banks, eight miles below the point where it issues from the *Llano Estacado*, is 2700 feet; just below the mouth of the North fork, 2000 feet; about 50 miles below the mouth of this tributary, 2100 feet; at the mouth of the Big Witchita, 600 feet; at Alexandria, 720 feet; at mouth of Black river, 785 feet; at mouth, 1800 feet. These numbers indicate the characteristic variation in width. While traversing the sandy desert, the river spreads out to a width greatly disproportionate to the depth; but when the more fertile and clayey soil is entered, it contracts to the normal dimensions corresponding to its discharge.

The depth of Red river varies inversely as its width, being only 6 or 8 feet, even in floods, throughout the desert, while it is some 50 feet in the fertile region. In extreme low water, a depth of 3 feet may be depended upon below Alexandria, about 4 feet thence to the head of the raft, and one foot thence to Fort Towson.

Steamers of 4 feet draught can ascend to Shreveport at any time except in extreme low water, but to Fort Towson or even Fulton, for only about three months in the year, and they frequently only run in one direction during a single rise.

The river above the raft rises and falls more rapidly than the

[2] The river takes its name from the reddish color of the water, probably derived from the red gypsum over which it passes.

Arkansas, and thus is less favorable to navigation. The raft also is a serious obstacle, as it requires the boats to leave the channel and pass through lakes and bayous.

The high-water area of cross-section throughout the desert country is probably about 12,000 square feet, and in the cultivated region from 30,000 to 40,000.

The range of the river is greatly affected by the raft. Thus at Fort Towson it is some 45 feet, the maximum (January 27, 1843) being 51 feet; at Fulton it is 35 feet; at the head of the raft, 10 feet; at Shreveport, 25 feet; at Alexandria, 47 feet; at the mouth, 45 feet. These numbers illustrate the effect of lakes in moderating floods.

The only important tributary of the Red river is the Black river, formed by the junction of the Washita, (the Indian name for Black,) Little river, and Bayou Tensas. It is only 54 miles in length.

The following figures exhibit the high water slope of Red river.

Locality.	Distance above mouth.	Elevation above gulf level.	Fall per mile.	Authority.
	Miles.	*Feet.*	*Feet.*	
Source,	1200	2450	0·00	Captain Marcy.
At Preston,	820	641	4·80	Captain Pope.
At Fulton,	595	242	1·80	Railroad levels.
At head of raft,	405	207	0·20	Mr. C. A. Fuller.
At Shreveport,	330	180	0·36	Railroad levels.
Mouth of Black River (high water 1828),	30	58	0·41	Delta Survey.
Mouth (high water 1828),	00	54	0·14	Delta Survey.

2. *Arkansas and White River Basin.*—This basin includes an area of 189,000 sq. m., the western portion of which lies among the summits of the Rocky Mountains, the middle portion comprises the great sterile plain between the mountains and 97° west long., and the eastern part, the rich alluvion of the Mississippi valley. Although diversified in climate and production, less than half this area is fitted to supply the wants of a civilized people.

Lieut. Pike, U. S. A., explored the sources of the Arkansas river in 1806. They lie among the Mts., west of the South Park, in lat. 39° and long. 106°, about 10,000 ft. above sea level. Half this elevation is lost in the first 150 miles. The stream then traverses a sterile hilly region, the hills gradually diminishing in size, till they subside into the plain westward of Bent's Fort, near 104° W. long. Maj. Emory's Report on Gen. Kearny's route in 1846 describes the river between Bent's Fort and Great Bend. It is seldom over 150 yards wide, and generally fordable. The bottom land a few feet above the water level varies from half a mile to two miles and is generally covered with good nutritious grass. Beyond Bent's Fort to the east, the 'big timber' is found, a thinly scattered growth of large cottonwoods.

Thence to Fort Smith, the river is described by Capt. Bell, who explored it in 1820. The bluffs here approach close to the river bed. Ravines become more abundant and like the river banks are well wooded. The water becomes slightly brackish from the saline springs near the right bank. Below the Cimmaron the river loses its pale clay hue and becomes reddish. Fort Gibson marks the head of navigation, beyond which the river, in the remaining 642 miles, traverses a fertile and settled region.

"The width of the Arkansas undergoes great variations. Near the mountains it does not exceed 150 feet. It gradually increases to about a mile, as it traverses the sandy desert. After entering the hilly and fertile region it varies from 1000 to 2000 feet.

The depth of the Arkansas also varies greatly in different parts of its course. Throughout the prairie region it averages about two or three feet, exclusive of shoals, but there are seasons when the water entirely disappears, being absorbed by the immense beds of sand in which its channel is formed. In the navigable part of the river the least depth found upon the bars in extreme low water, from the mouth to the Post of Arkansas, is from 2·5 to 3·0 feet; thence to Little Rock, two feet; thence to Fort Gibson, one foot.

The range of the river between low and high water is about 45 feet at Napoleon; 40 feet at South bend; 35 feet at Little Rock; 25 feet at Fort Smith; 10 feet at Fort Gibson, and still less at points above. These numbers do not represent the *extreme* ranges, although they are much greater than those that usually occur.

There are generally three annual rises in the Arkansas. As observed by Colonel Charles Thomas, U. S. Army, who served at Fort Gibson many years, they are as follows: One usually begins in February, owing to the winter rains, and lasts, on an average, about fifteen days. The next—the principal rise in the year—is occasioned by the melting snows in the mountains and the late spring or early summer rains. It occurs in May and June, and continues into July, and sometimes into August. The river generally keeps up, between these two rises, some one or two feet above its lowest stage. The last rise is in November, produced by the late autumn rains, and lasts from ten to twenty days.

Steamboats from three to four feet draught can almost always reach a point some 40 miles above Little Rock, and during the floods can reach as far as Fort Smith and Fort Gibson, with a fair prospect of being able to return. Both the Canadian and Arkansas have been navigated with small steamers as far up as the wants of the military service have required. Steamers of eight feet draught have reached Fort Smith, but their return during the same rise is not certain. The river is generally very low after the November rise. During the lowest stage it is difficult for boats of the lightest draught to reach Fort Smith.

The greatest flood of the Arkansas on record occurred in 1833. Authorities differ as to its relative height at Little Rock, but the evidence tends to the conclusion that it exceeded any subsequent flood by at least two feet."

The high water slope of the Arkansas is thus stated:

Locality.	Distance above mouth.	Elevation above sea level.	Fall per mile.	Authority.
	Miles.	*Feet.*	*Feet.*	
Source, - - - - - -	1,514	10,000	0·00	Captain Fremont.
Mouth of Boiling-spring river,	1,364	4,880	34·13	"
Mouth of Apishpa creek, -	1,323	4,371	12·41	Captain Gunnison.
Near Bent's fort, - - -	1,289	3,672	20·56	"
Near Fort Atkinson, - -	1,095	2,331	6·91	"
Great bend, - - - -	992	1,658	6·53	Major Emory.
Near Fort Gibson, - -	642	560	3·14	
Near Fort Smith, - - -	522	418	1·18	Lieutenant Whipple.
Near Little Rock, - - -	250	252	0·61	Railroad levels.
Mouth, - - - - - -	0	162	0·36	Railroad levels.

The Arkansas has two noteworthy tributaries. The Canadian, which rises in the Raton pass, 6000 feet above sea level, after traversing in a course of 1000 m. the same barren region through which the Arkansas flows, empties into the latter midway between Forts Smith and Gibson. The White River drains the fertile region which crosses the Arkansas above Fort Gibson. Its sources are about 1200 feet above the Gulf.

3. *St. Francis Basin.*—This region, including an area of 10,500 sq. m., consists of the St. Francis bottom and its watershed.

"By the former is understood the belt of swamp lands and low ridges lying between the Mississippi river and the line of high hills which extends almost continuously from Cape Girardeau to Helena. Some small portions of this area do not drain into the St. Francis river, but, being similar in character, the entire region is properly designated by a general name.

A portion of the southern slope of the Ozark mountains constitutes the chief watershed of this region.

As the St. Francis bottom lands are the most northern of those regions which have been generally considered "vast reservoirs for the flood waters of the Mississippi," great efforts have been made to collect all possible information about their real character. Extended personal inquiries and measurements have been made in many different localities. The surveys of the military road from Memphis to the St. Francis river, made by Dr. William Howard, U. S. civil engineer, in 1833; those of the Memphis and Little Rock railroad company, made in 1854; those of the Fulton and Little Rock railroad company, made in 1855 (?); and those of the route from St. Louis to Fulton, made in 1850, under the direction of the Bureau of Topographical Engineers, War Department, by Joshua Barney, C. E., have all been carefully studied. Much assistance has also been derived from the admirable chapter upon the swamp lands of southeastern Missouri, contained in the report of Messrs. O'Sullivan and Morley, engineers of the St. Louis and Iron Mountain railroad company, and published with the second annual report of the board of directors of that road (St. Louis, 1854). Together with its accompanying maps, this work furnishes nearly all the general information which could be desired about the Missouri portion of these bottom lands.

Boundaries and areas.—The St. Francis bottom is bounded as follows: Starting at Cape Girardeau, on the Mississippi river, the line runs a little south of west to the northwest corner of T. 29, R. 11, east; thence southwest to the St. Francis river, near the northeast corner of T. 26, R. 7, east; thence south along the St. Francis river[3] to the southeast corner of T. 22, R. 8, east; thence southwest to the northeast corner of T. 14, R. 4, east; thence nearly south to the middle of T. 3, R. 3, east; thence to Helena, and thence, following the Mississippi river, to Cape Girardeau. Within these limits there are many isolated ridges entirely above overflow.

The limits of the watershed of the St. Francis basin can be readily and exactly traced upon Hutawa's sectional map of Missouri, by following the divide which separates small streams running to and from the bottom lands. The Ozark slope constitutes fully two-thirds of the entire region.

The following table has been carefully computed in accordance with the above boundary, and is believed to be quite accurate:—

	Square miles.
Watershed of St. Francis bottom lands,	3,600
Ridges known to be above overflow in St. Francis bottom lands,	600
Lands liable to be submerged in " " "	6,300
Total area of St. Francis basin,	10,500

Topography.—The northern watershed is a broken, hilly country, sloping very abruptly to the bottom lands. Its mean descent southward is about 1200 feet in 70 miles, or at a mean rate of about 17 feet per mile.

The swamp region is, in general character, a great plain sloping from north to south at a mean rate of about 0·7 of a foot per mile, judging by the fall of the Mississippi between Cape Girardeau and Helena; and from east to west at a mean rate of about 0·5 of a foot per mile, judging by the levels of the Memphis and Little Rock railroad, which crossed the bottom near the middle line. This country is separated from the rolling praries west of it, which drain into White river, by a single narrow ridge averaging 300 feet in height."

4. *Missouri Basin.*—[The account of this basin having already been given in these pages, [2], xxxiii, p. 185, we omit it in this place.]

5. *Upper Mississippi Basin.*—Although the Upper Mississippi is neither the longest tributary, nor the greatest contributor of drainage, nor the branch most like in character to the great Mississippi, it bears its name and has thus always been an object of especial interest to geographers.

"The distinguishing characteristic of this portion of the Mississippi basin is the entire absence of mountains. Near the source of the river, the country is only some 1600 feet above the level of the sea, and is covered with swamps and lakes, divided by hills of sands and boulders be-

[3] The St. Francis river, when in flood, loses some of its water in this vicinity by bayous connecting with Black river, a tributary of White river of Arkansas.

longing to the Drift epoch. The middle and southern portions of the basin consist of prairie land, and are rapidly becoming cultivated. The agricultural and mineral resources of this basin are great, the climate is salubrious, and the country must eventually sustain a large and wealthy population. Its total area is 169,000 square miles."

Lake Itasca, in which the Upper Mississippi rises, is described by Mr. Schoolcraft as a beautiful sheet of deep water, seven miles long and from one to three broad. Nicollet, in 1836, determined its geographical position and elevation to be 47° 14′ N. lat., 95° 02′ W. of Greenwich. The elevation of the lake, by barometrical observations, he places at 1575 feet above the ocean level.

The Mississippi passes through several lakes and by successive rapids and waterfalls to the Falls of St. Anthony where it falls in less than three quarters of a mile a distance of 65 feet. Two tables given in the report exhibit the most important facts respecting this region.

Low-water slope of Upper Mississippi.

Locality.	Distance above mouth of Missouri	Elevation above sea.	Fall per mile.	Authority.	Remarks.
	Miles.	*Feet.*	*Feet.*		
Utmost source, - -	1330	1680	0·00	Mr. Nicollet.	
Itasca lake, - - -	1324	1575	17·50	"	
Entrance to Lac Travers,	1234	1456	1·32	"	
Entrance to lake Cass,	1189	1402	1·20	"	10 miles through lakes.
Mouth Leech-lake river,	1109	1356	0·57	"	35 miles through lakes.
Head of falls of Peckagama,	1061	1340	0·33	"	
Mouth Swan river, -	998	1290	0·73	"	Rapids intervening.
Mouth Sandy-lake river,	960	1253	0·95	"	Rapids intervening.
Mouth Pine River, -	863	1176	0·79	"	Rapids intervening.
Mouth Crow-wing river,	815	1130	0·95	"	Rapids intervening.
St. Paul, - - - -	658	670	2·93	R. road levels.	Sauk rapids, falls of St. Anthony, etc.
La Crosse, - - -	514	639	0·22	" "	
Prairie du Chien, -	453	600	0·64	" "	
Head Rock Island rapids,	310	505	0·66	" "	
Foot " " "	295	483	1·47	" "	Rapids intervening.
Mouth, - - -	0	381	0·35	" "	Des Moines rapids intervening (low-water fall 21 feet).

"These elevations refer to the low water of the Mississippi. The range between high and low water level is about 20 feet near Sandy-lake river; about 20 feet at St. Paul; about 10 feet (extreme, 14 feet) at La Crosse; about 12 feet (in 1858, 18·5 feet) at Prairie du Chien; about 16 feet at Rock Island; about 20 feet at Hannibal, and about 35 feet at the mouth. These ranges are much less than those of the Ohio, and, excepting the Missouri, of the other tributaries of the Mississippi, where they pass through the cultivable region. Their small extent is due to the generally flat character of the basin, from which the drainage is consequently slow; the existence upon it of numberless lakes; the great width of the river; the gradual change in season that takes place along its course; and the comparatively dry climate of the upper part of the basin."

The following table exhibits a correct list of the tributaries.

Name.	Distance of mouth above mouth of Missouri.	Length of Tributary.	Remarks.	Name.	Distance of mouth above mouth of Missouri.	Length of Tributary.
	Miles.	Miles			Miles	Miles
Source branch,	1324		Itasca lake.	Crow river,	699	
Turtle river,	1180	40	Cass lake.	Rum river,	690	150
Leech-lake river,	1109	50		Rice river,	683	
Mash-kudens river,	1055			St. Peter's river,	663	
Swan river,	998		Rapids intervening.	St. Croix river,	631	168
Sandy-lake river,	960		"	Vermilion river,	620	
Willow river,	930			Cannon river,	611	82
Pine river,	863	140	"	Chippeway river,	581	165
Crow-wing river,	815		"	Embarras river,	562	
Nokay river,	806			White river,	560	
Belle Prairie creek,	796			Black and La Crosse rivers,	516	128[1]
Elk creek,	782			Root river,	511	83
Pike creek,	787			Upper Iowa river	489	
Swan river,	786			Wisconsin river,	448	338
Two rivers,	777			Turkey river,	425	
Spunk river,	773			Wabesipinnicon river,	320	205
Platte river,	771			Rock river,	291	245
Little Rock creek,	760			Cedar river,	245	255
Watab and Winnebago rivers,	757			Skunk river,	205	
Lower Watab,	754			Des Moines river,	165	402
Sauk river,	752		Rapids 1 mile.	Illinois river,	24	397
Nechoado river,	744			Missouri river,	0	
Clear-water river,	73 6					
Elk or St. Francis river,	705	100		[1] Black river.		

6. *Ohio Basin.*—

"The Ohio river drains the northeast portion of the Mississippi basin—a fertile and populous region throughout nearly its whole extent. The southern tributaries rise in the Alleghany mountains, and flow northward through an undulating and beautiful country to the main stream. The northern tributaries have their source in the crest of the level plateau which lies immediately south of the great lakes, at an elevation varying from 500 to 1000 feet above their water surfaces, and flow southward through a fertile prairie and undulating country to the Ohio. The boundaries of the basin are indicated on plate I, and its character is so well known as to require no description here. Its total area is 214,000 square miles.

Ohio River.—The Ohio is formed by the junction of the Alleghany and Monongahela rivers. The former, which is the principal branch, rises in the mountains of Pennsylvania, the latter in those of Virginia. Throughout its whole length (975 miles) the river flows with a gentle current, uninterrupted by rapids except at the "falls of Ohio" near Louisville, when it descends 26 feet in three miles. It traverses a beautiful valley and is constantly augmented by tributary streams.

The Ohio in low water is a succession of long pools and ripples, with a current alternately sluggish and rapid. The bars in the upper part of the river are mainly composed of gravel, and in the lower part, of shifting sand.

Of the Alleghany branch, nothing need be said except that near its sources it flows between hills, through a very narrow strip of fertile bottom land, and with a more uniform slope than near the mouth, where it traverses a rocky and precipitous ravine, with a bed composed mainly of sandstone or gravel-bars. [Captain Hughes, Topl. Engrs., U. S. A.]

Of the Monongahela branch, some curious facts stated by Dr. William Howard in 1833 merit attention. It rises in the Alleghany mountains and subordinate ranges in Virginia, and is formed by the junction of the East and West branches and Cheat river. The former streams head in Laurel ridge, and flow in rocky channels. The tributaries of Cheat river rise in the summit of the Alleghanies, and form mountain torrents until they unite in a river scarcely less wild than themselves. The Cheat forces its way through deep gorges with nearly perpendicular side slopes to the Monongahela, falling 2400 feet in the last 80 miles. Below the junction the river is gentle in character. It winds with a serpentine course, without islands, through a terraced valley. Its slope here is *less than that of the Ohio.* Thus the fall from the mouth of Cheat river to Brownsville (35 miles) is 44 feet, or 1·26 feet per mile, and from Brownsville to Pittsburg (55 miles) only 31 feet, or 0·56 of a foot per mile; while the corresponding fall of the Ohio near Pittsburg is about one foot per mile. The fall of the Monongahela, above the junction of Cheat river, averages about two feet per mile for over 100 miles. The anomaly in slope near the mouth of this river is less in high than in low water, the usual range at Brownsville being 15 or 20 feet more than that at Pittsburg. At low water the Monongahela is a succession of pools separated by bars composed of gravel and loose stones, not subject to sudden changes. Its water is quite free from sedimentery matter."

Low-water slope of the Ohio, according to Ellet.

Locality.	Distance above mouth.	Elevation above tide.	Fall per mile.
	Miles.	*Feet.*	*Feet.*
Mouth of Ohio,	0	275	0·00
Mouth of Wabash (approximately),	130	297	0·17
Evansville (approximately),	187	320	0·25
New Albany, below the falls,	358	353	0·20
Louisville, above the falls,	361	377	8·00
Cincinnati,	515	432	0·36
Portsmouth,	620	474	0·40
Mouth of Great Kanawha,	714	522	0·51
Head of Le Tart's shoals,	769	555	0·60
Marietta (mouth of Muskingum),	800	571	0·52
Wheeling,	889	620	0·55
Pittsburg,	975	699	0·92
Franklin,	1105	960	2·00
Warren,	1175	1187	3·24
Chautauque lake,		1306	
Olean point,	1225	1403	4·32
Mouth of Oswaya,		1419	
Smithport,		1480	
Coudersport,	1265	1649	6·15
Surface of lake Erie,		565	

"It will be noticed that these elevations correspond to the low-water period. The range between extreme low and extreme high water seems to be about 45 feet throughout the entire river. Thus, at Wheeling,

it is 45 feet; at Louisville, 42 feet *on* the falls and 64 feet *below* them;[2] at Evansville, 40 feet; at Paducah, 51 feet; and at the mouth of the river, 51 feet. The usual range does not exceed 25 feet."

7. *Yazoo Basin.*—The Yazoo basin, having an area of 13,850 square miles, consists of the Yazoo bottom and its watershed. The Yazoo bottom is an alluvial tract, oval in shape, bordering on the Mississippi between Memphis and Vicksburg. It consists of 6800 square miles of lands liable to be submerged, 310 square miles of ridges and 6740 square miles of lands draining into the bottom. It is in general a vast densely timbered plain, sloping from the Mississippi toward the east at a mean rate of about 0·4 of a foot per mile. There are three classes of land in the Yazoo bottom, "high land," rarely overflowed, middle land, overflowed during the wet season, and the low "cypress swamps," parts of which always contain water.

The Yazoo river, from its proper source, Horn Lake, to the Mississippi, is about 500 miles long, and is navigable 240 miles to Greenwood, for boats drawing two or three feet. Indian mounds are found through the entire bottom.

8. *Basins of Small Direct Tributaries.*—Four of these will be noticed. Their total area is 32,400 square miles. This country is situated where the rain is greatest, and contributes more than is generally supposed to the discharge of the river.

"*Maramec basin.*—The northern slope of the eastern portion of the Ozark mountains drains into the Maramec river, a stream which enters the Mississippi a few miles below St. Louis. This basin is hilly in character, containing no lands liable to inundation. Its area, taken from Hutawa's sectional map of Missouri, is 5470 square miles. This estimate includes all the country between the Missouri and Cape Girardeau, on the right bank, which drains directly into the Mississippi.

Kaskaskia basin.—Under this head is included all the region draining into the Mississippi on the left bank, between the mouth of the Missouri and the mouth of the Ohio. It is named from its principal stream, although there are others of considerable size—the Big Muddy, for instance. The country is mainly prairie, but, upon the immediate bank of the Mississippi, a considerable area is liable to inundation in great floods. The "American bottom," between the mouths of the Missouri and Kaskaskia rivers, contains the greater part of this swamp country, but there is another limited belt above Cairo. The area of the whole basin is about 9420 square miles.

The Kaskaskia river itself resembles the Illinois. It flows with a very crooked course through a heavily timbered alluvial bottom, liable to be overflowed to a depth of eight or ten feet in freshets. Its bed is almost dry in the summer, but when high the stream has a strong current.

[2] At a medium stage of water, a rise of one foot on the falls makes a rise of about three feet below them, until the water on the falls is about five feet deep. Subsequently, the rate of rise below is rather less than two feet.

Obion basin.—Between the Ohio river and the head of the Yazoo basin lies an extended tract of country, which, for want of a better name, has been designated the Obion basin. It is drained by four nearly parallel rivers: the Obion, the Forked-deer, the Hatchee, and the Wolf; the Hatchee alone being, properly speaking, a navigable stream. The area of the entire region is about 10,250 square miles.

This region is in the main an upland, hilly country, but, as shown on plate II, the Obion and Forked-deer rivers flow through somewhat extensive swamps near their mouths. It is generally believed that the great earthquake in 1811, which depressed so much country on the opposite bank, materially increased the area of these swamps.

The Hatchee river, before certain railroads were built, was an important avenue for transporting cotton from the interior to the Mississippi. It is navigable to Bolivar—some 150 miles—from four to six months in the year; its usual range between low and high water being about 15 feet at Bolivar and 30 feet at its mouth. Its average high-water width is about 350 feet, and its high-water cross-section about 8000 square feet.

Big-Black basin.—The region draining into the Mississippi between the mouth of the Yazoo river and the alluvial lands below Baton Rouge is classed under this general head. It is drained by many streams, the two principal being the Big Black, which enters the Mississippi just above Grand Gulf, and the Homo Chitto, which enters below Ellis cliffs. Excepting a narrow strip along the immediate bank of the Mississippi, this whole basin is made up of a rolling, hilly country, entirely above any danger of inundation. Its area is about 7260 square miles."

Following this account of the various tributaries of the Mississippi, the authors proceed to discuss the river itself below the mouth of the Missouri. This is done in the second chapter of their volume, the contents of which have been given in the article already referred to (vol. xxxiii, p. 187). We hope to revert again to this portion of the report, and perhaps to other geographical discussions which the volume contains.

The figures which illustrate the character of the main river and also of the tributaries described in the present article, are summed up in the following tables, which will be of permanent value to all who are interested in the study of the great Mississippi valley. In conclusion, we desire to express our admiration of the thorough and comprehensive manner in which the investigations of Messrs. Humphreys and Abbot have been conducted. The work reflects the highest honor upon the fidelity, patience and science of the distinguished authors.

TABULAR VIEW OF THE MISSISSIPPI AND ITS TRIBUTARIES.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks.	Least low water depth upon the bars	Range between low and high water.	Area of cross section at high water
	Miles.	Feet. low water	Feet.	Feet.	Feet.	Feet.	Sq. feet.
Ohio river.							
Coudersport,	1265	1649					
Olean point,	1225	1403	6·15				
Warren,	1175	1187	4·32				
Franklin,	1105	960	3·24				
Pittsburg,	975	699	2·00				
Wheeling,	889	620	0·92			45	
Marietta,	800	571	0·55	1200			50,000
Head Le Tart's shoals,	769	555	0·52		1·0		
Mouth Great Kanawha,	714	522	0·60				
Portsmouth,	620	474	0·51				
Cincinnati,	515	432	0·40		2·0		
Above falls,	361	377	0·36			42	
Below falls,	358	353	8·00			64	
Evansville,	187	320	0·20		1·5	40	
Mouth Wabash,	130	297	0·25	3000			150,000
Mouth,	0	275	0·17		3·0	51	
Remarks.—Area of basin, 214,000 sq. m.—Downfall of rain, 41·5 in.—Annual discharge, 5,000,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·24.—Mean discharge per second, 158,000 cu. ft.							
Upper Mississippi.		low water					
Utmost source,	1330	1680					
Itasca lake,	1324	1575	17·50	15			50
Entrance to Lac Travers,	1234	1456	1·32	150			
Entrance to Lake Cass,	1189	1402	1·20	175			1,400
Mouth Leech-lake river,	1109	1356	0·57				
Head falls of Peckagama,	1061	1340	0·33	120			
Mouth Swan River,	998	1290	0·73				
Mouth Sandy-lake river,	960	1253	0·95	300		20·0	
Mouth Pine river,	863	1176	0·79				
Mouth Crow-wing river,	815	1130	0·95				
St. Paul,	658	670	2·93	1200		20·0	
La Crosse,	514	639	0·22		2·0	14·0	
Prairie du Chien,	453	600	0·64			18·5	
Head Rock Isl'd rapids,	310	505	0·66	5000		16·0	100,000
Foot Rock Isl'd rapids,	295	483	1·47				
Mouth Missouri,	0	381	0·35		2·0	35·0	
Remarks.—Area of basin, 169,000 sq. m.—Downfall of rain, 35·2 in.—Annual discharge, 3,300,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·24.—Mean discharge per second, 105,000 cu. ft.							
Missouri river.		low water					
Source Madison fork,	2908	6800(?)					
Three forks Missouri,	2824	4319	29·52				
Mouth Sun river,	2689	3573	5·54				
Foot of falls,	2670	2964	31·59				
At Fort Benton,	2644	2845	4·56	1500		6	
At Fort Union,	1894	2188	0·88				
At Fort Pierre,	1246	1475	1·10	2500	1·0		
At Sioux City,	842	1065	1·01				
At St. Joseph,	484	756	0·86	3000		20	75,000
At mouth,	0	381	0·77			35	
Remarks.—Area of basin, 518,000 sq. m.—Downfall of rain, 20·9 in.—Annual discharge, 3,780,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·15.—Mean discharge per second, 120,000 cu. ft.							

TABLE—CONTINUED.

River.	Distance from mouth.	Elevation above sea.	Fall per mile	Width between banks	Least low water depth upon the bars	Range between low and high water.	Area of cross-section at high water
	Miles.	Feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.
Arkansas river.		high wat					
Source,	1514	10000					
Mouth Boiling spring r.	1364	4880	34·13	150			
Mouth Apishpa creek,	1323	4371	12·41				
Near Bent's Fort,	1289	3672	20·56				
Near Fort Atkinson,	1095	2331	6·91	5000	0·0	6	30,000
Great bend,	992	1658	6·53				
Near Fort Gibson,	642	560	3·14		1·0	10	
Near Fort Smith,	522	418	1·18	1500		25	70,000
Near Little Rock,	250	252	0·61		2·0	35	
Mouth,	0	162	0·36			45	

Remarks.—Area of basin (including White r.), 189,000 sq. m.—Downfall of rain (including White r.), 29·3 in.—Annual discharge (including White r.), 2,000,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·15.—Mean discharge per second (including White r.), 63,000 cu. ft.

Red river.		high wat.					
Source,	1200	2450		2000		8	12,000
At Preston,	820	641	4·80			40	
At Fulton,	595	242	1·80		1·0	35	
At head of raft,	405	207	0·20			10	
At Shreveport,	330	180	0·36	800	3·0	25	40,000
Mouth Black river,	30	58	0·41			45	
Mouth,	0	54	0·14				

Remarks.—Area of basin, 97,000 sq. m.—Downfall of rain, 39·0 in.—Annual discharge, 1,800,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·20.—Mean discharge per second, 57,000 cu. ft.

Yazoo river.		high wat.					
Horn lake,	500	210					
Greenwood,	240	140	0·27	850	2·5	36	17,000
Mouth,	0	103	0·16			48	50,000

Remarks.—Area of basin, 13,850 sq. m.—Downfall of rain, 46·3 in.—Annual discharge, 1,350,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·20.—Mean discharge per second, 43,000 cu. ft.

St. Francis river.		high wat.					
Source,	380	1150					
Head swamp region,	275	330	7·81				9,400
Chalk bluffs,	225	280	1·00				2,300
M. and L. R. railroad,	55	209	0·42	700		40	21,000
Mouth,	0	200	0·16				37,000

Remarks.—Area of basin, 10,500 sq. m.—Downfall of rain, 41·1 in.—Annual discharge, 990,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·90.—Mean discharge per second, 31,000 cu. ft.

Main Mississippi.		high wat.					
Mouth of Missouri,	1286	416·0					
St. Louis,	1270	408·0	0·500		2·0	37·0	
Cairo,	1037	322·0	0·497			51·0	
Columbus,	1076	310·0	0·571	4470	5·0	47·0	191,000
Memphis,	872	221·0	0·436			40·0	
Gaines' landing,	647	149·0	0·320				
Natchez,	378	66·0	0·309	4080	6·0	51·0	199,000
Red-river landing,	316	49·5	0·266			44·3	
Baton Rouge,	245	33·9	0·220	3000		31·1	200,000
Donaldsonville,	193	35·8	0·156			24·3	
Carrolton,	121	15·2	0·147			14·4	
Fort St. Philip,	37	5·2	0·119	2470		4·5	199,000
Head of passes,	17	2·9	0·115			2·3	
Gulf,	0	0·0	0·171			0·0	

Remarks.—Drainage area, 1,244,000 sq. m.—Downfall of rain, 30·4 in.—Annual discharge (including 3 outlet bayous), 21,300,000,000,000 cu. ft.—Ratio between downfall and drainage, 0·25.—Mean discharge per second, 675,000 cu. ft.

RECENT EXPLORATIONS ENCOURAGED BY THE SMITHSONIAN INSTITUTION.

Those who have paid attention to the Reports of the Smithsonian Institution are aware that one method by which that establishment has contributed to the advancement of science has been the encouragement of expeditions in different parts of this continent, for the collection of specimens in natural history, and for the observation of physical phenomena. The report recently distributed, which covers the proceedings of the Institution for the year 1861, contains some interesting information respecting the progress of several explorations.

Explorations in the Peninsula of California, by Mr. John Xantus.—Mr. Xantus, having previously distinguished himself as a collector in natural history, by the researches which he made from the summer of 1857 to the autumn of 1858, in the neighborhood of Fort Tejon,—was placed by the superintendent of the Coast Survey, Prof. Bache, in charge of a tidal station at Cape St. Lucas. He reached the cape in April, 1859, and since that time he has made, says Prof. Baird, "collections which vie in thoroughness with those of Fort Tejon, and exceed them in number of species, embracing as they do marine as well as fresh water and land forms." In another connection, we learn from Prof. Baird, the following noteworthy facts. Besides the addition of a larger number of new animals to our fauna than has been made by one person in any single region of North America before, Mr. Xantus has shown that the most interesting relationship exists between the land species of the Cape and those of the region of the Gila, Upper Rio Grandé, and the southern Rocky Mountains. On the other hand, very few of the characteristic species of the coast of Upper California occur at the Cape; while, as far as observed, the same may be said of the strictly Mexican types. The entire Peninsula thus proves to be as specially related to North America in its land fauna as is Florida, although the number of peculiar species is much greater.

The marine fauna of Cape St. Lucas proves to be quite Panamaic in its general features—much more so than that of the opposite coast of Mexico.

The whole of the collection made by Mr. Xantus had not arrived in Washington when the report for 1861 was closed, but sixty boxes, some of large size, had been received. It is known that he has collected about twenty new birds, as many reptiles, large numbers of fishes, crustaceans, and other groups in proportion. The collection of shells is much larger than any ever made on the west coast, with the exception of that made by Mr. Reigen, forming the basis of the report on Mazatlan

shells, by Mr. Carpenter, and is superior to any other in the extent of the species preserved entire in alcohol.

In addition to the thorough exploration of the region immediately round Cape St. Lucas and the mountains of the vicinity, Mr. Xantus pushed his examinations many leagues up the coast, both on the ocean and gulf side, and also to a number of the neighboring islands, Socorro, Tres Marias, etc. He also made a visit to Mazatlan, and secured a valuable collection of birds. Mr. Xantus has now returned to the east, and the new species which he discovered are in process of elaboration and will shortly be published. Partial reports have already been made by Mr. Xantus on the Birds; on the Reptiles by Mr. Cope; on the Fishes by Mr. Gill; on the Insects by Dr. Le Conte; on the Crustacea and Asteriadæ by Mr. Stimpson; on the Ophiuridæ by Mr. Lyman; on the Myriapoda by Mr. Wood; on the Bats by Dr. Allen; on the Plants by Dr. Gray. The conchology is in the hands of Mr. P. P. Carpenter.

It is proposed, when all these examinations are completed, to combine their results in one general memoir on the Natural History of the Cape, which will then be as well known, or even better known than the extremity of the corresponding peninsula of Florida.

We copy, from Prof. Baird's report for 1861, the following statements respecting the other recent explorations in which the Smithsonian Institution has been concerned.

"*Exploration of the Hudson's Bay territory by Mr. Kennicott.*—At the date of the last advices from Mr. Kennicott, when the Smithsonian Report for 1860 was presented, he was at Fort Resolution, on Slave lake, where he had spent the preceding spring and summer, principally in collecting eggs of birds. He left Fort Resolution in August, 1860, and returned to Fort Simpson and proceeded immediately down the Mackenzie to Peels river. From Peels river he crossed the Rocky mountains to La Pierre's house, occupying four days in the transit, and arriving September 18th; left the next day for Fort Yukon, at the junction of Porcupine or Rat river and the Yukon or Pelly river, in about latitude 65° and longitude 146°. Fort Yukon, the terminus of his journey, was reached on the 28th of September, 1860.

The latest advices now on file from Mr. Kennicott were written January 2, 1861, up to which time he had made some interesting collections; but these, of course, were limited by the season. He had great expectations of success during the following spring, (of 1861,) which have no doubt been abundantly realized.

No collections were received from Mr. Kennicott in 1861, with the exception of a few specimens gathered in July and August, 1860, on Slave lake. Those made at the Yukon will, however, in all probability come to hand in October or November of 1862.

Mr. Kennicott expected to remain at the Yukon until August, 1861, then to start for La Pierre House and Fort Good Hope, possibly to Fort Simpson, to spend some months, and endeavor by early spring to reach Fort Anderson, near the mouth of Anderson river, (a stream between the Mackenzie and Coppermine rivers,) and in the barren grounds close to the Arctic ocean. At Fort Anderson he expected to collect largely of the skins and eggs of birds, rare mammals, &c., and to return to Fort Simpson in the autumn, (of 1862,) then to arrive at Fort Chipewyan, on Lake Athabasca, by the spring of 1863, so as to get back to the United States by the winter of the same year.

For a notice of the continued aid to Mr. Kennicott, rendered by the gentlemen of the Hudson's Bay Company, I have to refer to the next division of my report.

Exploration of the Hudson Bay territory by officers of the Hudson Bay Company.—The gentlemen of many of the Hudson Bay Company's posts have largely extended their important contributions to science, referred to in the preceding report. A large proportion of the principal stations have thus furnished collections of specimens and meteorological observations of the highest value, which, taken in connexion with what Mr. Kennicott is doing, bid fair to make the Arctic natural history and physical geography of America as well known as that of the United States.

Pre-eminent among these valued collaborators of the Institution is Mr. Bernard R. Ross, chief factor of the Mackenzie River district, and resident at Fort Simpson. Reference was made in former reports to his contributions in previous years; those sent in 1861 are in no way behind the others, embracing numbers of skins of birds and mammals, some of great variety, insects, &c., besides very large series of specimens illustrating the manners and customs of the Esquimaux and various Indian tribes. Mr. Ross has also deposited some relics of Sir John Franklin, consisting of a gun used by him in his first expedition, and a sword belonging to the last one, and obtained from the Esquimaux. Mr. Ross is at present engaged in a series of investigations upon the tribes of the north, to be published whenever sufficiently complete, and illustrated by numerous photographic drawings.

In making up his transmissions to the Institution, Mr. Ross has had the co-operation of nearly all the gentlemen resident at the different posts in his district, their contributions being of great value. Among them may be mentioned Mr. James Lockhart, Mr. William Hardisty, Mr. J. S. Onion, Mr. John Reed, Mr. N. Taylor, Mr. C. P. Gaudet, Mr. James Flett, Mr. A. McKenzie, Mr. A. Beaulieu, &c.

Second in magnitude only to those of Mr. Ross are the contributions of Mr. Lawrence Clarke, Jr., of Fort Rae, on Slave lake, consisting of many mammals, nearly complete sets of the water fowl, and other birds of the north side of the lake, with the eggs of many of them, such as the black-throated diver, the trumpeter swan, &c.

Other contributions have been received from Mr. R. Campbell, of Athabasca; Mr. James McKenzie, of Moose Factory; Mr. Gladmon, of Rupert House; Mr. James Anderson, (a) of Mingan; Mr. George Barnston, of Lake Superior; and Mr. Connolly, of Rigolette. Mr. McKenzie

furnished a large box of birds of Hudson Bay, while from Mr. Barnston were received several collections of skins, and eggs of birds, new and rare mammals, insects, fish, &c., of Lake Superior.

It may be proper to state in this connexion that the labors of Mr. Kennicott have been facilitated to the highest degree by the liberality of the Hudson Bay Company, as exercised by the directors in London, the executive officers in Montreal, (especially Mr. Edward Hopkins,) and all the gentlemen of the Company, in particular by Governor Mactavish, of Fort Garry, and Mr. Ross. In fact, without this aid the expense of Mr. Kennicott's exploration would be far beyond what the Institution could afford, even with the assistance received from others. Wherever the rules of the company would admit, no charge has been made for transportation of Mr. Kennicott and his supplies and collections, and he has been entertained as a guest wherever he has gone. No charge also was made on the collection sent from Moose Factory to London by the company's ship, and in every possible way this time-honored company has shown itself friendly and co-operative in the highest degree to the scientific objects of the Institution.

Northwest Boundary Survey, under Mr. Archibald Campbell.[3]—This expedition has finally completed its labors in the field and returned to Washington, bringing rich results in physical science, as well as important collections in natural history. These, with what were previously sent hither from time to time, are in progress of elaboration, and reports are in preparation to be presented to Congress when completed.

It is with deep regret that I have to announce the death at sea, on his homeward voyage in February last, of Dr. C. B. Kennerly, the surgeon and naturalist of the Boundary Survey. Connected with this expedition from its beginning, in 1857, and, in conjunction with Mr. Gibbs, making the principal portion of its collections, his report on them would have been one of great value. For many years prior to 1857, however, he had been in intimate relations with the Institution as a collaborator, first while resident at his home, at White Post, Clark county, Virginia, then in 1853, as surgeon and naturalist to the Pacific Railroad Survey of Captain Whipple along the 35th parallel, then in the same relationship to the Mexican Boundary Survey, under Colonel Emory, in 1855. No one of the gentlemen who have labored so zealously to extend a knowledge of the natural history of the west within the last ten or twelve years has been more successful than Dr. Kennerly. Many new species have been first described by himself or from his collections, while his contributions to the biography of American animals have been of the highest interest.

REPORT OF THE SUPERINTENDENT OF THE U. S. COAST SURVEY FOR 1860.

The promise of a paper illustrating the recent progress of the U. S. Coast Survey, has led us to postpone any notice of the report of the Superintendent for 1860, until it is almost time for us to expect the publication of the report for 1861. But as this

[3] Compare Dr. Hayden's account of this survey, Geog. Notices, No. XVII, this Journal, [2], xxxiv, 99.

Journal reaches many who do not see the Superintendent's elaborate review of the operations of the survey, we here transcribe those paragraphs which exhibit the chief geographical results of the year in question. The importance of the survey has never been more apparent than it is at present. The wisdom, energy and science of the Superintendent are more and more evinced as the work of successive years is made known to the public.

General Statement of Progress.—The Atlantic triangulation, as the accompanying sketch (No. 37) shows, is continuous along the coast of twelve States from Pasamaquoddy to the boundary of North and South Carolina, a stretch of more than twelve hundred miles, measured in the most general way. With an interval of some fifty-four miles, which is diminished every year by the party at work there, the triangulation is again continuous over the coast of South Carolina to Cumberland sound, on the coast of Georgia, two hundred and eighty miles. Then there is an interval of twenty-seven miles, which this season will fill up to the St. John's river, Florida; and the triangles are again continuous to Matanzas inlet, south of St. Augustine. Two parties are working, from Matanzas inlet south, and from Indian river inlet north, to fill up that interval, to which a third will next season be added, proceeding north from Cape Florida. Another season or two at most will fill up the whole space from Cape Florida to Cape Sable, and along the keys from Key Biscayne to Key West and the Marquesas. Charlotte harbor is triangulated, and the work extends from Anclote key to Cedar keys, ninety miles; from Ocilla river, by St. Mark's and Apalachicola, to Cape San Blas, ninety-five miles; over St. Andrews's bay; includes East bay, Maria de Galvez, Escambia, and Pensacola bays; touches the entrance of Perdido bay; extends from Mobile bay one hundred and fifty miles to Lake Pontchartrain, and over Chandeleur and part of Isle au Breton sound to the delta of the Mississippi, the greater part of which it now includes; over Isle Dernière and Caillou bay; over Atchafalaya and Côte Blanche bays; and from East bay (Galveston) two hundred and fifteen miles, passing over Matagorda, Aransas, and Corpus Christi bays and their dependencies, to within one hundred and fifteen miles of the Rio Grande.

The progress on the western coast has not been less satisfactory, taking the newness of the survey there into consideration. It has included all the harbors of California and Oregon, and many of those of Washington Territory, especially those of Washington sound, Puget's sound, and Admiralty inlet, the straits of Haro and Rosario, and part of the Gulf of Georgia, in the northwest.

Having given, in my letter of last year, a statement of the progress of the astronomical and magnetic work, I need not repeat it here. The longitude problem has been steadily kept in view, and the occurrence of the total solar eclipse, the path of which crossed from the northwestern part of the United States, through Washington Territory and the British possessions, leaving the continent on the coast of Labrador, has been made available for the correction of longitudes and of the lunar tables by parties sent out for the purpose in connection with those of other departments of the government, and in correspondence with the great astronomical expeditions of Europe.

The number of geographical determinations published by the Coast Survey, exclusive of those made within the past year, is seven thousand one hundred and seventy-eight; the magnetic variations given are upwards of two hundred; the tidal constants for harbors and coasts, one hundred and ten; and the maps and charts of harbors, bays, inlets, sounds, shoals, &c., drawn, engraved, and published, three hundred, exclusive of progress sketches and diagrams."

Maps and Charts.—"Within the past year, one hundred and eleven sheets have been worked on in the Drawing Division. Of this number, nine are finished charts, thirty-nine are coast maps and charts, twenty-one finished maps of special localities, sixteen preliminary, and two of the number are comparative charts. These are exclusive of twenty-four sketches of various kinds. Fifty-six of the sheets referred to have been completed, and fifty-five are in progress. Of those completed, twelve are maps and charts of the first class, and an equal number charts of special localities. Eight of the number are preliminary charts and two comparative charts; and the remaining twenty are sketches, amongst which are included those showing the field progress.

In the Engraving Division, eight first class maps and new editions of two have been completed during the year, and twenty-four are in progress. Of this class twenty-two were commenced in previous years and twelve within the present year. In addition, seventeen plates have been engraved of second class charts and sketches, and five plates of that class are yet in hand. This gives a total of twenty-seven plates completed and twenty-nine in progress, or of fifty-six plates engraved or engraving within the year.

The complete list, giving the titles of these maps and charts, is appended to the report of the assistant in charge of the office, and a general list of all that have been engraved up to the present date also accompanies it, (Appendix No. 19). The complete list includes three hundred and eleven titles, of which sixty-eight are of first class or finished maps. The total given is exclusive of seventeen plates of progress sketches.

Developments and discoveries.—During the year, in twenty localities important developments and discoveries were made, including the determination of various reefs and ledges, investigation of channels and currents, &c., with other like services to navigation.

Special Surveys.—Three special surveys, at the expense of local authorities, have been conducted during the year, viz: at Mobile, to ascertain the changes and condition of the bay; at Boston, for a like purpose; and on the peninsular of Cape Cod, to determine the feasibility of a canal connecting Buzzard's Bay and Cape Cod Bay.

Tidal Stations.—Six tidal stations have been maintained on the Atlantic coast, three on the Pacific, and two on the Gulf.

Measurements of heights.—In conjunction with the Smithsonian Institution, the Superintendent remarks, we have been engaged for some years in endeavoring to obtain all the data existing for heights in North America. During the past year a new circular has been issued to the engineers, presidents and superintendents of railroads, and to geologists, explorers, and other men of science, to obtain additional results, and with much success. To the entire number issued, two hundred and fifty re-

plies have been received. These furnish data for the height above tide of about thirteen thousand points, of which a large portion has been contributed by the explorations for routes for the Pacific railroad, and a considerable number by other surveys of the Government. The material received has been mapped by Mr. W. L. Nicholson, who is charged with the details of the work, so as to indicate whether the data were likely to suffice for the construction of contour lines of the surface of the continent, and to show where they would be deficient for that purpose. Sources of information have been pointed out, of which we have not yet been fully able to avail ourselves, but the work has, in a general way, made good progress, and will be earnestly prosecuted."

Besides information on these various topics, the report contains an account of the expedition to Labrador, to observe the Solar Eclipse of July 18, Prof. Bache's Lecture on the Results of the Gulf Stream Explorations, a discussion of magnetic declination or variation, and the usual details respecting the apparatus and *personnel* of the establishment.

DESIDERATA IN EAST AFRICAN EXPLORATION.

The following Note was recently addressed to the Bombay Geographical Society, by a Committee of the Royal Geographical Society of London, in reply to certain inquiries.

"Beginning at the south, we may look upon the Nyassa as entirely in the hands of Livingstone and other Zambesi travellers, such as Count Thurnheim. Livingstone, as we know, has established easy access to the southern end of the lake, and announced his intention of exploring the whole of it at the earliest opportunity. It would be a waste of resources to direct new travellers to that same district.

Proceeding northward, the itineraries of native traders supply enough information for the present rude wants of African geography, of the country between Quiloa and Nyassa; and we have received slight but definite knowledge of the same through Röscher's ill-fated expedition, followed up as it was to some degree by Baron von der Decken.

Taking yet another step, we arrive at the track of Burton and Speke, who have certainly left nothing of primary importance undescribed. The fourth and last section of known country is to the eastward of Mombas, whence Baron von der Decken (accompanied by the English geologist, Mr. Thornton) has lately travelled to Kilimanjaro, and where he still proposes to travel.

"Thus there is no urgent call for a new expedition that should leave the coast of Africa between the Zambesi and Mombas; but Eastern Africa is almost untouched between Mombas and the Red Sea. The field that here awaits new explorations is too vast to be exhausted by any single expedition. Three distinct undertakings may be specified.

"The first is to ascend the Juba, the Ozi, and other rivers, as far as they are navigable. They have all been visited by slavers, and opposition might be experienced on entering them, partly from that cause and

partly owing to hostilities between the Somauli and the Massai; but no serious obstruction need be apprehended by a well equipped party, large enough to command respect.

"The second and most difficult would be a land exploration through the Somauli. Their language is an obstacle to a traveller from the side of Zanzibar, where interpreters cannot be engaged; while the religious and the political fanaticism of their northern tribes is an equal bar to travellers from Aden, where a suitable expeditionary party might, perhaps, be collected. The most promising course would be to land at Mogadoxo, and to reside there some months, learning the language and acquiring a hold on the good will of the people, before attempting further progress.

"Additional interest is given to this exploration by the fact that Lieut.-Colonel Rigby, H. B. M.'s Consul at Zanzibar, is firmly persuaded that some Englishmen are now in captivity among the Somaulis; for a report to that effect has been confirmed by different witnesses. He believes them to be a part of the crew or passengers of an East Indiaman, supposed to have been wrecked near the Mauritius in 1855, but whose cargo, or rather a number of miscellaneous effects resembling those known to have been carried by her, are come into the possession of the Somaulis. An exploring party would find in this report an intelligible pretext for their presence in the land, and a stimulating object for their earlier movements.

"The last course would be to adopt Mombas as the head-quarters, and thence to pass into the interior by a route to the north of that travelled by Baron von der Decken. The country behind Mombas is a less unhealthy residence than other parts of the coast; and an expeditionary party might be organized there at leisure, with help from Zanzibar. The Rev. Mr. Krapf resides in its neighborhood; the natives are accustomed to Europeans; and the traders mostly speak Hindustani. It would be impossible, at the present time, to plan an exploration in Africa that would afford hope of a more interesting discovery than one leading from Mombas round the northern flank of Kenia, and thence onward toward Gondokoro."

ART. XXVI.—*On the existence of a Mohawk-valley Glacier in the Glacial Epoch;* by JAMES D. DANA.

THE Mohawk river extends in a nearly east-and-west course (averaging about east-by-south,) across the centre of the State of New York, and connects with the Hudson river near Troy, eight miles above Albany. It commences its flow eastward at Rome, west of Oneida lake, the waters above this coming from the Black river country, on the north. The whole distance from Rome to Albany, in an air line, is about 100 miles; the descent to the Hudson is 425 feet—equivalent to 4¼ feet to the mile. 78 feet of the descent, however, is at Cohoes falls, a mile from its

mouth, so that, for the rest of its course, the average descent is a little less than 3½ feet per mile.

The valley is a depression between the northern and southern plateaus of the State, and has its highest border on the south—the general height of the northern plateau being from 1000 to 1500 feet, and that of the southern plateau from 1500 to 2500 feet. It is not a synclinal valley; neither is it a valley of denudation, although, beyond doubt, greatly deepened and extended by the action of waters; but it is what the writer has styled a *geoclinal* valley, that is, one formed by the uplift of the crust of the earth on either side, (or else by the depression of the crust along its course,) without any conformity to its slopes in the dip of the enclosing rocks.[1] These enclosing rocks of the Mohawk depression are in fact, on one side, partly (above a height of a few hundred feet) the folded and crystallized Azoic, and, on the other, the Palæozoic rocks which were uplifted at a much later period.

About midway between Albany and Rome, the valley-depression, taking only the part *south* of the Mohawk, measures, at an elevation of 1500 feet, ten or twelve miles in breadth. But just east of this in Schoharie county, it opens southward along the valley of the Schoharie creek, the principal southern tributary of the Mohawk. This Schoharie valley is bounded, on the *west*, by the northwestern prolongation of the Catskill Mountains, having here a height of 2000 to 2600 feet above the sea level; on the *east*, by a spur from the same mountains, called the Hellebark mountains, which increases in height southwardly from 1000 to 2000 feet, and at whose eastern foot, in Albany county, lie the Helderberg hills, 800 to 1200 feet high above the sea-level. The principal heights of the Catskills, between 3400 and 4000 feet in altitude, are situated to the south, not far from the junction of the two ridges. The range of the Catskills has a height, at the Mountain House, according to Guyot's measurements, of 2235 feet above the sea-level. The true *watershed* lies a little to the south and west of this, and is made by Guyot 1970feet in elevation; and from it, flow waters northwestward to the Schoharie and eastward to the Hudson.

On the *north* side of the Mohawk, land 1500 feet in elevation is not met with except at very distant points from the river—as in the Black river region, towards Lake Ontario, which has this height, and in the Adirondack region, towards Lake Champlain, whose highest peak, Mt. Marcy, runs up to 5379 feet.

The Mohawk valley is continued westward in the depression of Oneida lake. The depression continues on farther west, just south of Lake Ontario. The Ridge road, as it is called, having

[1] The word *geoclinal* is derived from the Greek γη *earth* and κλινω *I incline*. The *Connecticut*, *Hudson*, and *Mississippi* are other *geoclinal* valleys.

a height of 631 feet above the sea-level, separates this depression from that of the lake; but the ridge is regarded as only a former beach of the lake.[2]

The ridges of Schoharie county form the western boundary of the great Hudson valley depression in that latitude—the *eastern* making the boundary, if we reckon only to a height of 1000 to 1500 feet, but the *western*, through the larger part of Schoharie county, if to a height of 2000 feet.

The preceding facts are mentioned, partly in elucidation of the following observations on glacier-markings along the Mohawk valley, and partly to show what course investigation must take in order to complete our knowledge of the great glaciers of the region in the Drift epoch.

The subject of river-terraces, or stratified Post-tertiary deposits, on the Mohawk and its tributaries, is also one of great interest in this connection, and merits a thorough examination. The deposits have some relation to the Drift, as they belong to the epoch immediately following—the Champlain epoch,—and consist in part, at least, of material that had been transported by the ice. They are of unusual extent on the East and West Canada creeks and other northern tributaries of the Mohawk.

The town of Cherry Valley is situated on the northern border of the southern of the New York plateaus. It is hence near the southern margin of the Mohawk valley, being about fifteen miles in a straight line from the river; at the same time, it is on one of the tributaries of the Susquehannah river, the general course of whose affluents is southward. Observations on the glacial scratches of this region have, therefore, a peculiar interest. The following are the results of important investigations on this subject, made by the Rev. William B. Dwight, as recently communicated to the writer. He states in his letter (dated Englewood, N. J.,) as follows.

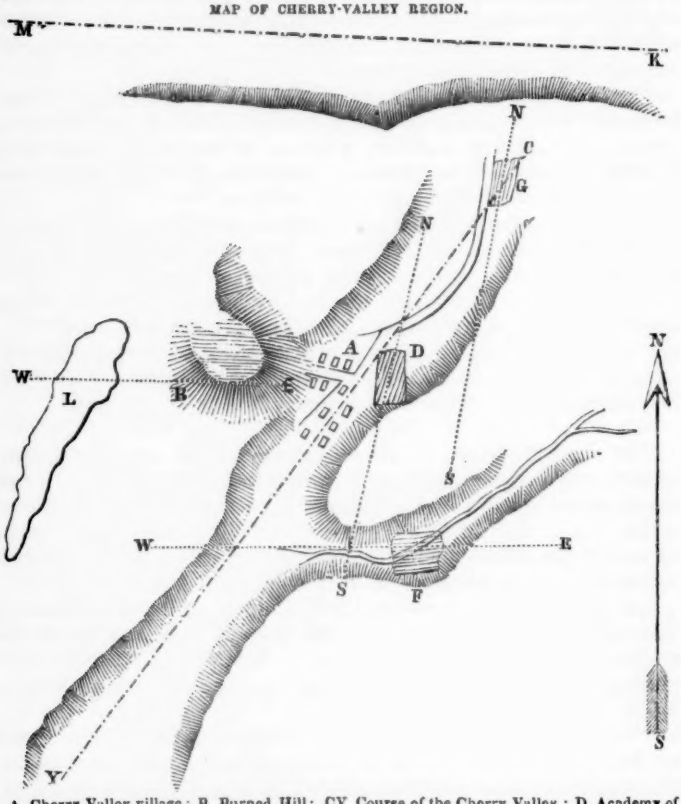
"As far as I have observed the glacial scratches of the State of New York, they do not conform in their course so much to the particular courses of the valleys in which they may be found, as they do to the trend of the general system of valleys.

"At Cherry Valley, there are *two* distinct sets of scratches nearly at right angles to each other, and *none between* these two. Both of these sets appear *in the valley itself*. Neither, however,

[2] The depression occupied by the Mohawk is situated, like those of nearly all the lakes of North America, and that also of the St. Lawrence, near the line of boundary between the Azoic and Palæozoic areas of the continent; that is, between the area that was comparatively stable dry land from the commencement of the Silurian age onward, and which reaches from Canada northwest to the Arctic and northeast to Labrador, and the area, stretching southward, southeastward and southwestward, from the Azoic, that was during the same time an area of progress and of unstable surface.

exactly conforms to the present trend of the valley, as shown on the accompanying map. The line CY corresponds to the trend of the valley, and MK to that of the Mohawk valley; and the two sets of lines, NS and WE, correspond to the direction of

MAP OF CHERRY-VALLEY REGION.



A, Cherry Valley village; B, Burned Hill; CY, Course of the Cherry Valley; D, Academy of Cherry Valley; F, Locality of Glacier scratches, half a mile below Cherry Valley; G, Id. on road to Fort Plain, north of Cherry Valley; L, Otsego Lake, head waters of Susquehannah; NS, Course of north-and-south system of scratches; WE, Course of east-and-west system of scratches; MK, Course of the Mohawk Valley

the respective glacier courses. The direction of the former sets of these scratches is about *north-northeast* and *south-southwest*, varying to *north-by-east* and *south-by-west*, and that of the latter about *east-by-north* and *west-by-south*.

"The Onondaga limestone of the region is, in many places, (as between the village and Judd's Falls) highly polished and deeply scratched, the scratches being mostly of the southerly system of courses. The same system is well exhibited on the side of the road leading to Fort Plain (at G), one and a half

miles north of Cherry Valley; and there is one long scratch in the cellar of the Cherry Valley Academy (D).

"Neither the scratches of the road-side, on the way to Fort Plain, nor that under the Academy, correspond with the general course of the valley, or even with its particular course at the locality of the scratches. They seem in every case to run somewhat into the hill-side.

"On the top of 'Burned Hill,' (B) on the west side of Cherry Valley, 400 feet above it, and 1800 feet above the sea-level, the rocky surface, here the Hamilton sandstone, wherever laid bare, over an area of several hundred acres, is more or less planed and scratched, and the scratches are of the *easterly* system, the course being east-by-north. Half a mile to a mile below Cherry Valley (F), there is another good locality of the east-by-north scratches. These easterly scratches have no apparent connection with any valley in the region.

"About a mile above Cobbles-kill Centre, a few miles east of Cherry Valley, on the Sharon road, there are scratches on the top of a hill of Corniferous limestone, having a *north-by-west* and *south-by-east* course. They have no relation in direction to Cobbles-kill valley, as they cross it nearly at right angles, and are evidently part of the same north-and-south system observed about Cherry Valley." [The Cobbles-kill flows eastward into the Schoharie, and not into the Susquehannah tributaries; but the place where these scratches occur is still near the summit of the plateau. All the above courses are *compass-courses*, requiring a correction of 6° for westerly variation.]

Mr. Dwight continues:—

"The best conclusions that I can gather from these facts is, that there are two systems of scratches in that part of the State, at right angles, nearly, to each other; that *one system* corresponds with the *general* direction of the great valleys running southerly, (those of the principal Susquehannah tributaries, though the correspondence is only one of general courses,) and that *the other system* corresponds with the direction of the Mohawk valley, although, where I have observed it, there is no modern valley in the immediate vicinity to correspond to it."

These conclusions of Mr. Dwight appear to be altogether just. The *east-and-west* courses are well explained by reference to the Mohawk valley; while the *north-and-south* system conforms to the slope of the Susquehannah tributaries, though possibly connected with a grander movement reaching from the far north across the Mohawk valley.

The Mohawk valley needs to be studied for a full elucidation of the subject. But there are some confirmatory facts stated by Vanuxem, who, as long ago as 1842, announced essentially the same general conclusion, as the result of his observations.[3]

[3] See New York Geological Report, Part III, comprising the Survey of the Third Geological District, by Lardner Vanuxem, 4to, 1842, p. 245.

In Montgomery county, near Amsterdam (on the Mohawk), this able geologist noted scratches at various quarries and localities on the Trenton limestone, which were nearly east-and-west in direction,—agreeing thus, as he remarks, with the course of the Mohawk valley. Again, in the same county, near Sprakers, on the north side of the Nose, the scratches conform, as he states, to the valley of the Mohawk. North-and-south scratches occur in the vicinity of this valley according to Vanuxem; but, at the places observed by him, they conform to one, or another, of the minor tributaries. In Oneida county, between Utica and New Hartford, there are north-and-south scratches on the Oneida conglomerate, which conform to the Sauquoit valley; and on the west of the Oriskany creek, north of Hamilton College, the same system occurs, and corresponds with the Oriskany valley. Vanuxem concludes, from his observations, that *the direction of the scratches corresponds with the direction of the valley in which they occur.*[4]

The question, whether these drift-scratches and other phenomena are a result of glaciers, or icebergs, the writer has discussed in his Geological Manual, and need not take up here.

The absence of well characterized moraines from the most of the country will not be deemed remarkable by those who consider the length of time which has elapsed since the Glacial epoch ended, and the power of running water in wearing to powder loose stones of whatever hardness, and especially those derived from most sedimentary strata.

Again, moraines are always comparatively small where the glacier has no towering peaks or cliffs about its course, to afford avalanches of ice and stones. The glacier of the Mohawk, in order to make scratches about Cherry Valley, 1800 feet above the sea-level must have reached to a height of at least 2000 feet; and with this level, if the region had anything like its present configuration, it would have buried a large part of the southern plateau, while its northern border would have had no limit in New York State, except about the Adirondack Mountains, 70 or 75 miles distant.

[4] Mr. Vanuxem observes, in concluding his remarks on this subject, that the *glacier-origin* of the scratches harmonizes with the fact that the scratched surfaces are found at no regular or defined elevations; that the surfaces are too much worn, and extend over too great an extent of the same rock, to have been caused by icebergs, especially, as the lines are always straight ones, and the motion of icebergs is oscillatory and rotatory. The direction also of the scratches is in accordance with existing valleys, and hence local, agreeing with glaciers in both respects." He adds further, with his usual discrimination, "As matter of fact from actual observation, the glacier-theory will have preference of the two, especially, should the term *local ice* be substituted, being a more general expression:—glaciers having their origin near the line where perpetual snow ceases, whereas *local ice* embraces the same, as well as all bodies of solidified water, be the cause of the reduction of temperature what it may, whether permanent or transient, that has given rise to it." p. 247.

On the Catskills, the glacier scratches reach to a height of at least 2235 feet—the elevation at the Mountain House, and this implies the existence of ice and snow to a height of at least 2600 feet; and if the snow had this height over the whole southern plateau, it would have almost completely buried it, with the exception of the higher Catskill summits.[5]

Without more extended observation, it is not possible to say whether the east-and-west, or the north-and-south, scratches of the Cherry Valley region are of earlier date. If the former, then, beyond question, the north-and-south are due to a *Susquehannah glacier;* but if the latter, they may have resulted, as already intimated, from a great continental glacier spreading southward from the remote north, of which the Mohawk glacier was a final portion that became partly outlined and independent only in the later part of the Glacial epoch. The fact of the greater average height of the southern plateau than the northern adds to the difficulties of arriving, at present, at sure conclusions; and the uncertainties, arising from our ignorance of the changes in the topography of the country through erosion, during the time which has since elapsed, still further enhance these difficulties. But, whatever the uncertainties, there is sufficient justness in the views of Vanuxem, Dwight and others, as to a frequent conformity between the direction of scratches and of the valleys, (the greater valleys,) to suggest the right method of investigation, and indicate the line in which a large part of the truth lies.

The facts gathered over much of New England appear to point directly to a *Connecticut-valley* glacier; and those between the Green Mountains and the Catskills, to a *Hudson-valley* glacier; and others, in the vicinity of Penobscot Bay, recently studied by Mr. De Laski, to a *Penobscot-bay* glacier, as this observer, after extensive research, has concluded. A *Mohawk-valley* glacier may, with little if any doubt, be added to the number already defined, and probably, also, a *Susquehannah-valley* glacier.

[5] Ramsay states, in his observations on the drift-scratches of the Catskill region (Quart. Jour. Geol. Soc. Lond., xv, 208), that while the striations on the ascent of the mountain from the east were "nearly north-and-south along the flanks of the escarpment, and not from west to east down the slope of the hill," and "very strong and frequent up to the plateau on which the Mountain House stands, 2850 [2235] feet above the sea," at this summit level, on the watershed, the scratches approximate to east-and-west. He says "on this plateau, numerous main grooves are seen, passing across the hill, and nearly at right angles to most of those observed during the ascent,—seemingly pointing to the fact that the icebergs [Mr. Ramsay adopting in his reasoning the iceberg-theory] which striated the eastern flank of the mountains in a north-and-south direction, when the whole was nearly submerged, here found a passage or strait through which they sometimes floated and grated the bottom, in a direction quite across that which they were forced to follow when passing along the great escarpment that now faces the Hudson." He states, also, that these main grooves are crossed "at various angles" by "minor striations." Mather, as mentioned in his Geological Report, made long since some similar observations on the Catskill scratches; but they were less complete than those by Ramsay.

ART. XXVII.—*On certain Changes in Wine;* by J. NICKLÈS.[1]

AMONG the different substances contained in wine, one of the most characteristic and constant, in connection with alcohol and water, is the bitartrate of potassa. Since a wine will not be accepted as a natural product if it lacks this salt, it is well known that the manufacturers are always careful to add the bitartrate of potassa to spurious wine. Nothing has ever changed this opinion, although numerous chemical researches have been made every year with the different wines produced in France. Natural wine always contains a proportion more or less appreciable of cream of tartar (bitartrate of potassa), if the wine has not undergone any change. Through recent investigations made at Lyons and at Montpellier it has been discovered that the bitartrate of potassa may be wanting in wines which have undergone decomposition, especially in such wine as has become bitter. Wine affected in this manner is known in France under the name of "changed wine" (*vin tourné*). It is very disagreeable to the taste, and gives by distillation volatile acids in much greater quantity than are furnished by normal wine.

It has also been remarked that "changed wine" contains more potassa than wine of the same province which has not been spoiled. But sugar and glycerine are not more abundant in such wine; on the contrary there appears lactic acid, which depends upon sugar for its production, and also another acid with the formula $C_6H_6O_4$, which is the formula for propionic acid, but which, as we shall see below, is here applicable to an isomeric acid.

It was at first thought that this volatile acid was derived from glycerine, which is normally contained in wine. But its origin is now explained, by a fact which we discovered in 1846 and published in a memoir inserted in the *Comptes Rendus* of the Academy of Sciences (vol. xxi, p. 285) entitled, "*Sur un acide particulier produit par la fermentation du tartre brut.*" This acid we call *butyro-acetic acid* because of the facility with which it may be transformed into acetic acid and into butyric acid, and also because it is possible to effect the synthesis of this acid, as we have formerly shown in the *Journal de Pharmacie et de Chimie*, xxxiii, p. 351. We shall refer to this synthesis below.

The production of an acid $C_6H_6O_4$ from the butyric acid or from the acetic acid may be rendered intelligible by means of the following equation:

$$C_4H_4O_4+C_8H_8O_4=C_{12}H_{12}O_8 \text{ : and } \frac{C_{12}H_{12}O_8}{2}=C_6H_6O_4 \text{ (?)}$$

[Acetic acid + butyric acid.] [Butyro-acetic acid.]

[1] Communicated to this Journal by the author.

Although this acid may arise from fermentation of bitartrate of potassa, it has never, for a wonder, been found in wine which has lost its tartaric acid by means of adulteration. This fact confirms the observation, made long since in the practice of wine making, viz: that when the wine became changed in this manner, all the crude tartar which had settled at the bottom of the casks disappeared little by little, an observation which confirms this other fact demonstrated by chemistry, to wit, that "changed wine" contains more potassa than is found in normal wine. This is evidently due to bitartrate of potassa originally deposited in the bottom of the cask, which by redissolving and fermentation has furnished this excess of potassa now dissolved by the aid of the lactic acid and of the butyro-acetic acid produced during fermentation.

The "turning" of wine which is characterized by the designation *changed wine* (*vin tourné*), and which follows when the wine becomes bitter, consists essentially in a transformation of sugar into lactic acid, and tartaric acid into an acid containing the elements of acetic and butyric acids, that is to say of butyro-acetic acid. Under the influence of this change the metamorphism of tartaric acid takes place not only when it is free and in solution, but even when it is combined with potassa and is deposited at the bottom of the cask in the condition of an insoluble bitartrate.

[2] The notation of Gerhardt shows clearly the difference between the two acids called propionic and butyro-acetic. Take for example the salt of baryta, the crystalline form of which is identical for the two acids (Rammelsberg, *Krystallographische Chemie*, ii, p. 161).

$$\left.\begin{matrix} \overset{''}{\mathrm{Ba}} \\ \mathrm{C_3H_5O} \\ \mathrm{C_3H_5O} \end{matrix}\right\}\mathrm{O_2} \qquad \text{and,} \qquad \left.\begin{matrix} \overset{''}{\mathrm{Ba}} \\ \mathrm{C_2H_3O} \\ \mathrm{C_4H_7O} \end{matrix}\right\}$$

Propionate of baryta. Butyro-acetate of baryta.

To obtain the butyro-acetic acid, it is only necessary to pass a solution of acetate and butyrate into a retort containing hot and dilute sulphuric acid, and to condense in a convenient vessel the vapors which are disengaged. The condensed liquid contains an acid which being neutralized by baryta gives beautiful flat prisms formed of butyro-acetate of baryta. These crystals have a greasy feel, and when pulverized and thrown into water they acquire a gyratory motion similar to butyrate of baryta. In this case the two acids, acetic and butyric, are evolved in the *nascent* state, and combines to form the *butyro-acetic acid* in question.

ART. XXVIII.—*Observations on the Sphagna of New Jersey, with Description of a New Species;* by C. F. AUSTIN, Curator of Dr. Torrey's Herbarium, Columbia College.

THE region in New Jersey known as "The Pines" is literally a region of *Sphagna*. Nine of the ten species and most of the varieties noticed in this paper were collected there by the writer in October last, in the vicinity of Manchester in Ocean county, within the radius of less than half a mile,—the fruits of a few hours search. One of them, *Sphagnum Sullivantianum*, is new to science; another, *S. molluscum*, to the American Continent.

The bottoms of the ponds in this region are covered to a great extent (often to the exclusion of all other plants which usually grow in such places) with *Sphagnum cuspidatum* var. *Torreyanum*, *S. macrophyllum*, large forms of *S. Pylæsii* and with *S. Sullivantianum*. They are entirely submerged (when at a depth of more than three or four feet), or have their tips just peeping from the surface of the water, and were all brought up together on the boat's oar in the pond at Manchester, from a depth of at least six feet.

The more or less inundated marshes on the borders of the ponds are filled with *Sphagnum cuspidatum*, running into the var. *recurvum* in the cedar swamps, where this variety abounds, and into the var. *plumosum* in shallow water,—and this appears to pass regularly into the var. *Torreyanum* in deep water. The forms of this species which run into the var. *recurvum* have a slender state of *S. cymbifolium* abundantly, and of *S. molluscum* sparingly, mixed with them. The common forms of *S. acutifolium* and *S. cymbifolium* form deep extensive turfs in the cranberry bogs,—these places seeming to be made up of their remains.

In sandy, grassy bogs, forming matted masses, *S. cyclophyllum* and *S. Pylæsii* are abundant. *S. rigidum*, var. *humile*, occurs sparingly on the dry margins of the ponds.

Considering the limited time and space over which the search extended, and the number of species collected, it is reasonable to suppose that others may yet be found in the same locality.[1]

The following brief synopsis includes, I believe, all the *Sphagna* that have thus far been found in New Jersey.[2]

1. SPHAGNUM ACUTIFOLIUM Ehrh.—Fruits abundantly on the borders of sandy swamps, where it is of rather a low stature; the taller forms which grow in peat bogs appear to produce only male flowers; color below whitish; above, brownish tinged with red, often changing to bright

[1] *S. subsecundum* is common in other portions of the State, and may be looked for in the same locality as well as all the American species not peculiar to high latitudes.

[2] Since writing the above, I learn from Mr. Sullivant that he has *S. tabulare* from Quaker Bridge, New Jersey.

purple in drying. A cinerous-green, rather loosely spreading, sterile form is found in miry swamps.

2. Sph. Sullivantianum (sp. nov.): Speciosum robustum submersum vel fluitans: caulis pedalis et ultra firmus simplex vel semel divisus, strato corticali triplici et quadruplici e cellulis hyalinis spirali-fibrillosis porosis formato; ramuli 3–5-fasciculati, quorum 2–3 recurvo-patentes densi julaceo-foliosi basi attenuati, 1–3 deflexi cauli adpressi graciliores laxius foliosi, cellulis corticalibus spiraliter fibrillosis haud porosis in strato duplici dispositis: folia caulina obovato-quadrata toto margine fimbriata, cellulis sine poris et fibrillis; folia ramulorum patulorum inferiora parvula semicirculari-ovata, cætera multo majora, media orbiculata cochleariformi-concava, terminalia elongato-ovata laxiuscula, omnia arcte imbricantia angustissime marginata, basi unguiculata, dorso ad apicem cucullatam papilloso, toto ambitu (foliis terminalibus exceptis) eleganter fimbriata, rete inferne elongato-rhomboideum apicem versus rhombeum, cellulis hyalinis fibrillosis et poris majusculis instructis, cellulis chlorophyllosis ad concavam folii faciem positis inque sectione transversali triangularibus: fructus et flores ignoti.—Manchester Pond, Ocean Co., New Jersey; collected October, 1862.

This fine species has the appearance of an overgrown state of *Sph. cymbifolium*, and possesses *in a superlative degree* most of the distinctive characters of that species, but is at once distinguished by its *clavate branches with elegantly fringed leaves which are very abruptly contracted below into a claw-like base*, and have the back at the apex conspicuously dark-colored, with cross-section as in *S. acutifolium*. The stem-leaves are also quite distinct, being usually nearly quadrate, but little if any longer than broad, and copiously fringed.

3. Sph. cymbifolium, Dill.—Allt he specimens that I have examined, both from this country and Europe, have the stem-leaves reticulated on the border above,—the network often broad and extending slightly beyond the margin, frequently giving the leaf a strongly fringed appearance,—and have the lower branch-leaves slightly spinulose-toothed; spinulæ short, distant, erect-appressed, somewhat club-shaped, with the apex slightly recurved. The following are the forms that I have observed in New Jersey, precisely the same as are found in Europe:—

α. Densely cespitose, low or tall, mostly of a pale reddish-brown color; stems erect; branches short, thick, straightish, remote or crowded; the loosely imbricated or spreading leaves straight on the back.—(β. *condensatum* C. Müll. *Synop.* 1, p. 92.)—Peat bogs and borders of sandy swamps; fruits occasionally; runs into

β. More robust, rather loosely cespitose, mostly of a pale glaucous-green color; stems erectish; branches attenuated, recurved, the lower rather distant, the upper crowded; stem leaves with the cells usually destitute of pores and spiral fibres; branch-leaves slightly recurved above the middle. (α. *pycnocladum* C. Müll. *Synop.* 1, p. 92).—Borders of swamps and in pastures. Very rare in fruit; runs into

γ. Loosely spreading and of a dark bluish-green color; stems zigzag; branches less crowded above,—the leaves acuminate, the upper half somewhat tubular and recurved-squarrulose. (γ. *squarrulosum* C. Müll. *Synop.* 1, p. 92).—Miry swamps partly inundated; sterile.

4. Sph. cyclophyllum, Sull. & Lesqx.—Foliis perichætalibus ut cæteris capsulam globosam includentibus.—Apparently a very distinct species; stem and branch-leaves much larger than in any other, often 2 lines or more broad by 2½–3 lines long, with a clasping-perfoliate, constricted, distinctly heart-shaped base.—Grassy bogs about Manchester. I have seen dwarf forms of this species from Quaker Bridge distributed as "*S. sedoides* Brid."

5. Sph. Pylæsii, Brid.—Also apparently a very distinct species, and, with the preceding (with which it grows, forming thin strata), very distinct from *S. sedoides*.—Color blackish-green; stems 6 inches long with few short recurved-spreading branches. Runs into a large dusky-black form in the water with stems 1–2 feet long.

6. Sph. rigidum, Schimp., var. humile. (*S. humile* Schimp.)—Stems low, 1 inch high, very compact; capsule nearly included.—Dry margin of the pond at Manchester.

7. Sph. subsecundum, Nees & Hornsch.—Rather loosely cespitose, 3–5 inches high; color above, a beautiful golden-brown, below, whitish; branches in fours and fives, somewhat crowded, thickish towards the base, somewhat attenuated, more or less contorted and of unequal lengths; branch-leaves ovate, acuminate, unequally truncate and about 5-toothed at the apex, varying from closely imbricated to spreading, mostly recurved, —some are much so, while others on the same branch are straight or even slightly incurved; cells of leaves larger than in any specimens that I have seen from other localities,—with numerous small pores.—Meadows and pastures in springy places; sterile.—A form growing in sunken holes, in woods partly inundated, is of a pale green color; stems 6–8 inches long, with rather distant branches arranged in fives and sixes; perichæth lateral. At a casual glance it might be mistaken for either *S. cymbifolium* or *S. acutifolium*, but particularly for *S. cuspidatum;* but it is at once distinguished from the first, with which it grows, by its smaller size and acute branch-leaves; from the second by its thickish branches with the leaves irregularly imbricated and recurved; from the last it is very difficult to distinguish it when fresh, but in a dry state this is readily done, for it then has the leaves straight (not wavy) on the margin; male plant very different from the female, as follows:

Compactly cespitose, 2–4 inches high; color brownish-green tinged with yellow; branches very short and thick, ovate-lanceolate, very acute, nearly straight, the deflexed ones are closely appressed beyond, but not at, the tumid base; branch-leaves large, orbicular-ovate, rounded at the 5–12 toothed apex, very compactly imbricated,—the cells mostly without pores.—Very difficult to distinguish from small forms of *Sph. cymbifolium*, var. α, with which it grows. Bogs and wet meadows: Bergen Co.

8. Sph. molluscum, Bruch.—Was found mixed with small forms of *Sph. cuspidatum* from about Manchester, and detected by its elliptical, never cuspidate nor recurved, branch-leaves, which are not wavy on the margin when dry; those towards the apex of the branches are smaller than the rest, but of the same outline (not narrowed as in most species). Resembles *S. tabulare* Sull., but is a more slender plant, with cross-section of leaf as in *S. cuspidatum*.

9. Sph. cuspidatum, Ehrh.—Rather loosely cespitose; large and robust

or small and weak; color whitish and greenish; stems erect, or spreading, 5–8 inches long; branches thickish, none closely appressed; stem and perichætal leaves not fibrillose; the latter crowded at the base of the lateral perichæth, often including the capsule; branch-leaves rather large, lanceolate acuminate, broadly margined.—Runs into the var. *plumosum*. —In an inundated peat bog in Bergen Co., there occurs a slender pale-green form with loosely spreading and fibrillose perichætal-leaves, which seems to connect this and the var. *plumosum* with var. *laxifolium*.

Var. RECURVUM. (*S. recurvum* Beauv.).—Densely cespitose, robust; color pale straw-yellow; stems erect, 5 or 6 inches high; branches in fours and fives, the 2 spreading ones very uniformly recurved, the 2 or 3 deflexed ones closely appressed; branch-leaves small, oblong-lanceolate, strongly recurved and conspicuously arranged in 5 straight ranks. Perichæth terminal. Runs into the preceding or typical form.—Cedar swamps about Manchester.—There is a deep green, loosely cespitose form in Bergen Co., which seems to connect this var. with the var. *laxifolium*.

Var. PLUMOSUM.—Larger than the preceding and much more attenuated in all its parts. Sometimes this variety is found scattered and creeping on the banks of the small streams in the cedar swamps, when it is much condensed, with short, very thick, contorted and much crowded branches, giving to the stems an obese appearance, suggestive of huge caterpillars. —Shallow water about Manchester.—Very rare in fruit; runs insensibly into

Var. TORREYANUM. (*S. Torreyanum* Sull., in *Memoirs Amer. Acad. Arts and Sciences*, new series, iv, p. 174).—This fine variety (it appears to be nothing more) and the var. *recurvum* seem to represent the two extremes of this species, between which there are all manner of intermediate forms.—Deep water about Manchester.—Probably does not fruit except when it occurs in water holes that are partially exsiccated during the late summer and early fall months.

Var. LAXIFOLIUM. (*S. laxifolium* C. Müll. *Synop.* 1, p. 97).—Nearly as large as the last and resembling it except in color, which is deep green, stem and perichætal leaves fibrillose except the margins below, the latter loosely spreading; commonly sterile, but I have a number of fine fruiting specimens from partially exsiccated water holes, in low sandy woods in Bergen Co., where this variety is common.

10. SPH. MACROPHYLLUM, Bernhardi.—This species is often found floating free, and has much the appearance of the var. *Torreyanum* of the preceding one, and cannot be distinguished from it when in the water except by its blackish stem and leaves. It is very apt to be mistaken for a decaying state of that plant; for, owing to the complete absence of the elastic spiral fibre in the utricles of the leaves, it has a characteristic dead appearance when removed from the water, and goes into a shapeless mass,—feels as if rotten, and resumes its former fine symmetrical outline but slowly, if again restored to its native element.—Abundant in the ponds in Ocean Co., where only the large sterile form was found.

New York, January, 1863.

Art. XXIX.—*Foreign Correspondence.*

1. *On the Science of the International Exhibition.* In a letter from O. C. Marsh, B. A., to Prof. Silliman, dated London, Nov. 25, 1862.

The International Exhibition, which has just closed, contained many objects of considerable scientific interest; and, in accordance with your request, I shall endeavor to give a short account of those which seemed most worthy of notice.

In every part of the Exhibition the practical application of the results of scientific research, rather than the results themselves, or the methods by which they had been accomplished, were especially selected for illustration. Hence, many of the classes, under which the various articles exhibited were arranged, contained few if any objects that need here be mentioned. In the present communication I shall notice briefly the principal points of Class I, which embraced Mining, Mineral products, and Metallurgy, and without doubt exhibited a fuller and more instructive collection of these objects than has ever before been brought together.

Gold.—The most striking feature in this division, and perhaps in the Exhibition itself, was the immense quantity of native gold displayed. The British colonies of Australia, New Zealand, British Columbia, and Nova Scotia contributed most of this, yet nearly every part of the world sent its representative specimens, and the collection was interesting, as showing the great number of new gold-fields discovered within the last few years, and as indicating the almost universal distribution of this metal. Most of the gold exhibited possessed in itself nothing of peculiar interest, and the processes for its separation, which were shown theoretically and practically, are generally well known. There was, however, in the Zollverein department, a series of specimens (No. 733[1]) from the arsenic works of Reichenstein, in Silesia, illustrating the extraction of gold by chlorine water, which seemed worthy of more attention than it received. The material used is auriferous mispickel, from which the arsenic is first separated by roasting.[2]

Silver.—The silver, exhibited in Class I, possessed few points worthy of mention, many of the most important mines not being represented, and others very inadequately. Some beautiful specimens of native silver were shown from the government mines of Kongsberg, Norway, and also from the Copper mines of Lake Superior; and a good collection of various ores from the Washoe mines of California. Specimens of silver-glance, horn-silver, and ruby silver, from a new locality in Newfoundland, were also exhibited.

Platinum and the platinum-metals.—The display of platinum, and its associated metals, iridium, osmium, palladium, rhodium, and ruthenium, was a marked feature in this class. A case in the British department (No. 171), containing all of these metals in their natural state, most of their known compounds, and many illustrations of their practical application, was one of the most interesting objects in the Exhibition, and

[1] The numbers refer to the Official Catalogues of the various departments.

[2] A series of the Reichenstein specimens illustrating Plattner's process was exhibited in the American Exhibition of 1853, No. 278, Class I.

deserves particular notice. A single ingot of pure platinum, weighing 3200 ounces, Troy, was the most conspicuous object in the case, and afforded a good illustration of the progress which this branch of metallurgy has recently made in consequence of the researches of Deville and others. The fusion of this mass of platinum was effected in an iron box, which was lined with small pieces of lime, and covered with a lid of similar construction. Two jets from compound blowpipes, using coal-gas and oxygen, were directed through the cover upon small pieces of platinum, introduced from time to time, and when the whole was completely fused, it was rapidly transferred to a mould. It is claimed that platinum apparatus, made from a solid ingot, will both be cheaper, and less liable to lose its firmness of structure on heating, than when manufactured in the usual manner, and the case contained a great variety of such articles. Among these was a large boiler for the concentration of sulphuric acid, an alembic for separating gold and silver by means of the same acid, and a pyrometer for indicating the variations of heat in boilers. Each of these articles was said to possess, in design and construction, several points of superiority over any similar apparatus hitherto made. Other objects of interest were platinum tubes, soldered with the same metal, and a sheet of copper, plated with platinum, showing that the many difficulties attending the production of these articles have now been successfully overcome. The same case contained an ingot of pure iridium weighing 27½ ounces, and a fine display of the natural and artificial compounds of this metal, among which were specimens indicating that the minute particles of the native alloy of iridium and osmium, formerly considered of little value, may be fused together, and thus used for pointing gold pens as advantageously as grains of larger size. Palladium, rhodium, and ruthenium were also represented by rich series of specimens, in quantities never before seen. Many other rare and interesting substances were exhibited in this case, among which may be mentioned various salts of uranium, boron and silicon, fused and crystallized, which Deville himself had prepared by the process that bears his name.

Aluminium.—Aluminium, also, was well represented in the Exhibition, and can no longer be regarded merely as a curiosity, since it is evidently taking a prominent place among the useful metals. In the British and French departments, its practical applications were illustrated by a great variety of interesting objects. Some of the more noticeable of these were philosophical instruments, for which this metal, from its lightness, strength, and difficulty of oxydization, seems so well adapted. Various alloys of aluminium, with copper, nickel, and other metals, were exhibited, and their usefulness illustrated in a great variety of ways. A series of aluminium tubes, in the French department, indicated that the difficult problem of soldering this metal has been successfully solved. According to the exhibitors, zinc was the solder used, and the operation was performed in an atmosphere of hydrogen.

Mercury.—Mercury and its ores were well represented in various parts of the Exhibition, the specimens of cinnabar from Almaden in Spain, and from the New Almaden mines of California, being especially conspicuous. Lead, zinc, cadmium, nickel, cobalt, arsenic, antimony, and many ores of these metals, were also fully represented, but the collections contained little

of especial interest. The display of tin, bismuth, and titanium was quite small, the only representations of the last metal being a few rutiles from the well known Georgia locality.

Copper.—Copper ores from nearly every part of the world were exhibited in this class; some of the most interesting specimens were very fine crystals of the native metal from Lake Superior, boulders of vitreous copper from a serpentine ("gabbro" of the Italians) dyke at Monte Catani in Val di Cecini near Volterra, in Italy, and a series of the Hungarian gray copper ores containing about ten per cent of mercury.

New Metals.—In the French department, the new alkali metals, cæsium and rubidium, with some of their salts, were shown; and also the new metal thallium,[*] the latest result of spectrum analysis. Manganese, obtained by a new process, was the most interesting object in Class I, of the Swiss department.

Iron and Steel.—Iron was naturally the most prominent object in an exhibition like the present, and no small part of the building was occupied by its various ores, illustrations of its Metallurgy and its applications. Although this collection was far superior in many respects to any hitherto made, the recent progress it indicated was rather, greater facilities for the production and application of this metal, than any new scientific information in regard to it. The chemistry of iron seems still to remain comparatively unknown. In the British department, some rolled plates for ships were fine illustrations of iron manufacture. The largest of these was 13 tons in weight; and the shattered fragments of those broken in the recent experiments of the English government were also exhibited. Dr. Percy, the distinguished metallurgist, who directed the experiments, states that an examination of the fractures thus made affords information in regard to the internal structure of iron, which other means of investigation have failed to detect, and that thus far the experiments indicate that the softest iron possible is most efficacious in resisting heavy shot. The exhibition contained many fine specimens of steel made by Bessemer's process, which seems likely to supercede many now in use. The display of cast steel by Krupp of Essen, Prussia, has never been equalled. One of his castings weighed 21 tons, and an examination indicated that its structure was uniform throughout.

Coal and artesian boring.—Different varieties of coal were shown in great profusion in Class I, but do not require comment. The great waste of this substance in the usual methods of mining is now attracting much attention, especially in England, and processes for rendering the small coal available for fuel were abundant in the exhibition. These were either improved grates, or methods for uniting the fine particles of coal, by heat, or by some bituminous cement. The apparatus used in boring through strata, in searching for coal, or in making artesian wells, formed an instructive series in the French department. It was exhibited by Degousée, author of "*Guide du Sondeur*," one of the best works on the subject.

Canadian collections: asterism in Mica.—Among other interesting objects in Class I, may be mentioned a collection of the economic minerals and crystalline rocks of Canada, sent by the directors of the Geological survey. The catalogue describing them is a work of much scientific

[*] Exhibited by Mr. Crookes also in the English Department.

value. In this collection were specimens of a magnesian mica, or phlogopite, from South Burgess, which quite recently has been found to exhibit the rare property of *asterism* in a remarkable degree. This has led to a new examination of the subject, and now this hitherto obscure point in optical mineralogy can be readily and satisfactorily explained. The asterism of this mica was, I believe, first observed by H. Vogel, of Berlin, during a recent visit to the exhibition. On his return he investigated the subject in company with Prof. G. Rose, who had observed a similar appearance, although much less distinct, in some varieties of meteoric iron. Prof. Rose has just communicated the results of the investigation to the Royal Academy of Berlin,[4] and the subject is of such general interest that the main points of his paper may not inappropriately be given in this connection.

If a thin plate of the mica from South Burgess be held between the eye and a light, there will be seen a large and distinct star, composed of six rays, and having the light as its central point. Between these rays, six others, smaller and much less distinct, may be observed. A similar star is seen by reflected light, but this is never so clearly defined. By holding the mica against the light, and examining it with a magnifying glass, a great number of minute prismatic crystals can be detected. Under the microscope these become perfectly distinct, and Vogel succeeded in photographing them when magnified 500 diameters. Most of the crystals are elongated, flattened prisms, having the broad lateral planes parallel with the laminæ of the mica. Their resemblance to crystals of kyanite is quite marked, and it is very probable that they belong to that species. Tabular crystals, also, may be seen, which are apparently quite different from the prisms. The crystals, with few exceptions, have a definite position in the mica, most of the prisms being parallel to the sides of an equilateral triangle, thus making angles of 120° and 60°. A few, however, make with the former an angle of 150°; and occasionally one is seen which has a still different direction. The general position of the crystals is best seen when a low power of the microscope is used.

Since the minute crystals have this regular position in the mica, the asterism is easily explained. It is a mere "trellis-appearance" (*Gittererscheinung*); and the rays of the star stand at right angles to the axes of those prismatic crystals which make with each other angles of 120°, and hence proceed from the center of the star to the middle of the sides of the equilateral triangle, with the sides of which the crystals lie parallel. As there are a few crystals which make angles of 150° with the former, intermediate, and less distinct rays are also observed. If then, a great quantity of minute crystals, regularly arranged in a larger crystal, can produce asterism, as in this mica, it must appear in other minerals also, where this is the case, and probably the cause of the asterism, wherever it has been observed, is the same as in the present instance.

In the same paper, Prof. Rose gave the results of his examination of the asterism in meteoric iron, and referred to the previous investigations on this interesting subject.

London, Nov. 25, 1862.

[4] G. Rose, *Ueber den Asterismus der Krystalle, insbesondere des Glimmers und des Meteoreisens.* Oct. 30, 1862. See also Phil. Mag., Jan. 1863.

2. *Correspondence of Jerome Nicklès, dated at Nancy, France, Nov. 2, 1862.*

Obituary.—Death has lately made great ravages in the scientific world in France. Among those who have deceased since the date of my last correspondence, should especially be mentioned *De Sénarmont*,[1] who was at once a physicist, a mineralogist and a crystallographer; *Count de Gasparin*, distinguished as an agriculturist, after having sustained an important political position; and *Jomard* the archeologist and geographer and the last survivor of the "*Institut d'Egypt*," that celebrated institution which was formed during the French revolution in connection with the Expedition to Egypt. The following particulars may be mentioned concerning these three savants.

Henri Hurran de Sénarmont, born at Broué (Eure et Loir) Sept. 6th, 1808, died suddenly July 4th, 1862, at the age nearly of 54 years. Of a distinguished family, he received a complete education, having entered the Polytechnic School in 1826 which he left to enter the School of Mines. In 1848 he was promoted to the rank of engineer in chief of mines, and in 1852 was elected a member of the Academy of Sciences, in the section of Mineralogy, in the place of Beudant. For many years he delivered the course of lectures on Mineralogy at the School of Mines. The works which he has published are numerous and varied, as is well known to the readers of this Journal, in which they have often been noticed.

We enumerate the following titles of his works, viz. "*Modifications que la réflexion sur un miroir métallique imprime aux rayons de lumière polarisée.*" "*Réflexion et double réfraction de la lumière par les cristaux doués de l'opacité métallique.*" "*Conductibilité des substances cristallines pour la chaleur.*" "*Conductibilité des cristaux pour l'électricité de tension.*" "*Formation des minéraux par voie humide dans les gites métallifères concrétionnés.*" "*Formation par voie humide du corindon et du diaspore.*" "*Propriétés optiques bi-réfringentes des corps isomorphes.*" "*Propriétés et formes cristallines des Micas.*" "*Production artificielle du polychroïsme dans les substances cristallisées.*" "*Memoires sur la double réfraction.*" "*Forme cristalline du Silicium.*" "*Modes d'accroissement des cristaux et causes de variations des formes secondaires.*"[2]

He was also connected as joint author with a great number of reports to the Academy upon different questions of physics, mineralogy, and crystallography.

He determined a great number of crystalline forms, which have been published by Rammelsberg in his "*Krystallographische Chemie*," and has made known in France, by an excellent translation, the treatise of Prof. Miller on Crystallography.

De Sénarmont was highly appreciated by Biot, who aided him much in his career, and left to him his sympathy for young students and his aversion to public functions which do not belong to the domain of science; withal he was exceedingly modest; elected in 1853 to the position of perpetual Secretary in the Academy of Sciences in place of Arago, he declined to accept it:[2] and upon his death-bed he directed that no eulogy should be pronounced at his tomb. He left many uned-

[1] See this Journal, [2], xxxiv, 304. [2] This Journal, [2], xvii, 263.

ited works which it is proper to hope will soon be published. His last labors were the publication of the works of Fresnel by virtue of a commission with which he had been charged by the Minister of Public Instruction. He had collected with care the scattered materials and had written a great number of explanatory notes. He had not had time to complete this work so earnestly waited for by men of science, which however will be published ere long.

Adrian Etienne Pierre De Gasparin was born at Orange (Vaucluse), June 29th, 1783. His father was a celebrated member of the Convention, and was distinguished at the siege of Toulon. Bonaparte, the exile of St. Helena, remembered in his will this young commander of artillery, who was afterwards a general, bequeathing a sum of money to the children of this revolutionary hero. They had no need of it, however, as they possessed an ample fortune.

The savant whom we have just mentioned was at first a soldier. Wounded in 1806, in the campaign in Poland, he retired to his home, devoted himself to the study of the natural sciences, and became noted for his interesting memoirs upon agriculture which obtained for him a distinguished position among cotemporary agriculturists. After the revolution of 1830, he was successively prefect, peer of France, Under Secretary of State, then Minister of the Interior (1836), and lastly Minister of Commerce and Agriculture. During his progress to power, he constructed roads in Corsica, reformed the discipline of prisons, and replaced the chain gang by portable cells. Returning to private life, in 1840, he resumed his agricultural studies. At this time he was elected a member of the Academy of Sciences, in the section of Agriculture, in place of Turpin. He devoted himself only to agriculture, and merited the title of successor of Olivier de Serres, whose descendant he was by reason of the marriage of one of his ancestors with the daughter of the founder of French agriculture.

Among his works should be mentioned especially his *Traité d'Agriculture* (6 vols. in 8vo.), his memoirs upon the multiplication of races, upon the contagious diseases of sheep, upon the raising of merino sheep, on the culture of madder, and of the mulberry. He made extensive investigations in meteorology, especially upon the distribution of rain, and published valuable experiments upon solar radiation. He died at Orange, his native village, the 7th of September, 1862. French agriculturists have already commenced a subscription for the erection of a statue to his memory.

Ed. François Jomard was born at Versailles, Nov. 22, 1777. He left the polytechnic school in 1794 and entered as geographical engineer in the school of surveying, (*École de Géographie du Cadastre*). At the age of 21 he joined the expedition to Egypt. At the commencement of the campaign he took part in forming a topographical plan of Alexandria, measured and drew the less known monuments under the direction of Monge, read upon this subject various memoirs at the Institute of Cairo, and collected, in company with the savants and artists chosen for this scientific mission, the materials which have been incorporated in numerous works. On his departure from Egypt, contrary winds having detained him in the Archipelago, he took the opportunity to explore the

Ionian Isles. Having been engaged on the "*Description de l'Egypte*," he afterwards became secretary of the commission appointed to publish the labors of the Egyptian Institute, which was important chiefly by reason of the interest which it inspired for Napoleon, and because most of its members became distinguished men.

In 1826, after much effort, he succeeded in establishing the Egyptian school of Paris. Every year the Egyptian government sends to Paris a certain number of young men to pursue their studies. The Viceroy of Egypt, Saïd-Pacha, is a graduate of this school. In 1828 Jomard was appointed administrator of the *Bibliothèque* for the new department of geography and travels, and was at the same time charged with the organization of this service, an organization of great advantage to history, science, commerce and travels. The most of the works of Jomard relate to geography, of which they include all branches.

Publication of the works of Lavoisier.—It was in 1836 at the College of France, in the course of his celebrated lectures on chemical philosophy, that Dumas undertook, as he says, the solemn engagement of collecting and publishing the complete works of Lavoisier. Since that time he has never ceased to be occupied with this idea; searching for documents in the papers of the family of Lavoisier, in the collections of autographs of various amateurs, and in the registers of the laboratory of the founder of chemistry. Dumas has succeeded in producing a complete work, full of new documents, as we have already mentioned, in our correspondence of the month of April, 1861, vol. xxxii, p. 99.

The funds for printing it have not been wanting: on the one hand the French booksellers could not do better than to undertake the publication of this work; on the other, the family of Lavoisier demanded the honor of publishing this monument to his memory; the city of Paris also claimed the same honor, and the Minister of Public Instruction, in the name of the state, claimed the right of paying this sacred debt of science to genius and misfortune. Consequently, the works of Lavoisier will be published at the expense of the government, but the family of the illustrious chemist add to the first volume a portrait of the philosopher.

The volume about to be published is the second: it contains 61 memoirs of Lavoisier composed during 22 years comprised between the dates of 1770 and 1792. "These are," says Mr. Dumas, "the memoirs characteristic of his work. After a careful examination I have resolved to arrange them in their chronological order giving to each its proper character and nomenclature, and to avoid adding, without the most absolute necessity, the least note to a text which in its admirable clearness had no need of annotation."

The note from which we cite these quotations was read lately by Dumas to the Paris Academy of Sciences. It is full of new and unpublished details in regard to the scientific life of Lavoisier, and a most interesting appreciation of his services. The reader will find it in the *Comptes Rendus* for Sept. 29th, 1862, pp. 526–528.[3]

[3] In the session of the Academy Nov. 10th, Becquerel communicated a notice of a number of manuscripts of Lavoisier discovered in the public library of the city of Orleans by Loiselell, the librarian; he enumerates and analyzes the chief of these documents, treating of political economy, of canals, of the junction of the Loire to

Ozone and Nitrous Acid.—Fixation of Nitrogen in Plants.[4]—For some time we have observed a certain change in the results of the labors of Schönbein. Where once he recognized only ozone he discovers now only nitrous acid or nitrite of ammonia. We are far from denying the importance, utility and scientific bearing of the researches of the learned chemist of Basle. But as one becomes somewhat acquainted with this subject it is evident that Schönbein has done justice tardily to those who have preceded him in this question. Of this number is T. Sterry Hunt, who, as our readers will remember, long since showed that nitrite of ammonia may be formed by means of nitrogen and water (*this Journal*, [2], xxxii, 109), and thus led the way to a new theory of nitrification. This is what Boettger arrived at, who first announced that nitrite of ammonia is a constant product of all combustion in the air.

The important discoveries which Schönbein has since made, and which are explained in the *Journal fur Prakt. Chemie*, lxxxvi, 129, and in the *Journal de Pharmacie et de Chimie*, xli and xlii, fully show that this point was entirely developed by T. Sterry Hunt, and became thus the occasion of objections which have been frequently made to the employment of paper saturated with starch and iodid of potassium (or ozonometric paper) for determining the presence of ozone in the air. Since by the sole fact of the evaporation of the water an appreciable quantity of nitrous acid or of nitrite of ammonia is produced, and since this product is increased when the water contains calcareous substances, it is evident that the coloration which is observed upon the ozonometric paper which has been exposed to moisture in contact with air does not indicate the presence of ozone, but only the greater or less energy with which the nitrite of ammonia is produced during the evaporation of the water which moistens the sensitive paper.

Another point of the highest importance which follows from these researches relates to vegetable physiology, viz., the assimilation of nitrogen by plants. This great question, which has been for some years so vigorously debated in France, and over the whole world of science, and which experiments tend to resolve affirmatively, the last researches of Schönbein elucidate by a fact previously unnoticed. Nitrite of ammonia is formed simply by the evaporation of the moisture collected by the leaves of plants (*Journal de Pharmacie et de Chimie*, Oct. 1862, p. 340); it is also formed every time that a body is burned in the air (Boettger confirmed by Schönbein); in the same manner its production accompanies a great number of chemical reactions, when they take place in the presence of air.

We thus find more sources of $AmONO_3$ than are necessary to explain the important fact, discovered by Boussingault,[5] of the nitrifica-

the Eure and to the Seine, on savings' banks, assurance, &c. He ends by the exclamation "Honneur au grand chimiste! honneur au grand citoyen!"

Abbé Mognio remarks in *Cosmos* (Nov. 14), 'it was not difficult to see that this communication annoyed M. Dumas, who considered himself alone entitled to explore the rich mine of the inedited works of Lavoisier.'

[4] An abstract of Schönbein's results has already been given on p. 111-113 of this volume. See also beyond, Hunt's note of reclamation on this discovery; also Prof. Hunt's correspondence, p. 271 (beyond).

[5] See his work entitled, "*Agronomie, Chimie Agricole et Physiologie.*" See also this Journal, [2], xix, p. 409.

tion of fallow land, to account for the origin of nitrogen in plants which have been raised out of contact with sources of ammonia.[6]

In a similar way we can explain the source of nitrogen in mycoderms, without supposing the intervention of a peculiar property of these cryptogams as was done recently by Jodin, a physiologist who observed that solutions containing sugar, tartaric acid, glycerine and phosphates, and free from nitrogenous compounds, organic or mineral, were yet able to produce rich mycodermic vegetables containing in the dry condition 4 to 6 per cent of nitrogen.

Enclosed in tubes hermetically sealed, in presence of an artificial atmosphere of oxygen and nitrogen, we easily show, says Jodin, a very notable absorption of nitrogen, and this absorption continues, within certain limits, even when the liquid contains an appreciable proportion of ammonia or of an albuminoid substance, such as milk. The absorption is measured by the development of vegetation. This absorption of nitrogen is explained by the formation of nitrite of ammonia which, as Schönbein has shown, always takes place in these conditions. The mycodermic plants are able to facilitate it by reason of their avidity for the salts of ammonia, which they take up in proportion to their production, and constantly freeing the soil they maintain it in a condition to form new proportions of nitrites.

The process employed by Schönbein to detect the presence of nitrous acid consists, (as is well known,) in the use of a solution of starch containing iodid of potassium, which he pours into the liquid to be examined, and to which he adds a little very dilute sulphuric acid. We may observe that this reaction serves quite as well to recognize the presence of ozone, chlorine, bromine, or iodine, as of aqua-regia, hypochlorous, or hypobromous acid: in fine, that, without wishing to throw any doubt upon the results obtained by Schönbein, we may still inquire whether it is proper to attribute to nitrous acid all the colored reactions produced in starch. For example, Schönbein admits that both the mortar of old walls and urine contain *great quantities of nitrous acid* (*Journ. de Pharmacie et de Chimie*, xli, 431), but it is sufficient that these substances contain chlorids, which is a constant fact—and frequently also nitrites. In presence of sulphuric acid, the alkaline chlorids give chlorohydric acid, which, with nitric acid, also set free, produces aqua-regia, the action of which upon iodid of potassium is well known.

Since this objection was presented to Schönbein (who formally rejected it), he appears suddenly to have taken it into consideration, for now he does not know whether the nitrous reaction produced by urine is due to the nitrous acid which it contains as such, or whether the aqua-regia is produced as we have just suggested.—(See *Journ. de Pharmacie*, for November, 1862.)

Electro-metallurgy.—A new kind of industrial Painting.—This new kind of painting, which is just now being applied to many monuments recently constructed in Paris, was invented by the artizan who established in France the *electro-metallurgy of copper*, Mr. Oudry, who, by a very simple process, has succeeded by the aid of electricity in covering

[6] On these questions see also "*Leçons faites à la Société Chimique de Paris en 1861*," p. 138, &c. *Paris*, chez Hachette.

statues and other ornaments in iron or brass with a thin layer of copper. One of his last works was the galvanic coppering of the monumental fountains in the *Place de la Concorde*. Three months sufficed him for covering 190,000 kilograms of iron with a layer of copper two millimetres in thickness, weighing nearly 16,000 kilograms. Persons who know that iron rapidly oxydizes in the presence of a layer of copper which covers it galvanoplastically would not anticipate very great durability for these works of art. They will have a different opinion when they know that the layer of galvanoplastic copper is nowhere in contact with the nucleus of iron, and that the two metallic surfaces are completely isolated from each other by a kind of varnish or glazing, which is applied with a brush and which dries very rapidly by reason of the benzine which it contains. The real novelty of the process consists in the application of this enamel and in the means employed for handling easily the huge pieces of metal on which the copper is to be deposited.

It is well known that the glazing is rendered a conductor by a layer of graphite. The piece to be coppered is plunged into the bath of the sulphate of copper and there acts as the negative metal; it is connected with the zinc pole or positive metal contained in porous vessels filled with acidulated water; these porous vessels are also placed in the bath. The whole as we see is an inversion of the pile of Daniell. Frequently also the porous vessels are replaced by bladders. The coppering of the two monumental fountains at the *Place de la Concorde* required the employment of 5700 bladders.

When the layer of varnish is well applied there is no danger of the oxydation of the iron. It is thought that a greater difficulty may arise from the unequal expansion of the two metals. The coefficient of dilation of cast iron is 0·00111, while the coefficient for copper is 0·00171. Although this danger is exaggerated, we should remember that the galvanoplastic copper is very porous. The copper is also very friable and easily pulverized. It is with this copper, reduced to an impalpable powder, that Mr. Oudry has effected his new style of painting; the powdered copper is diffused in varnish prepared in benzine, which serves for a coating to the brass or iron which it is proposed to cover with copper by this process.

As we see, the preparation of this color is not difficult, and it is prepared without very great expense. It is easily applied to wood, plaster, cement, brass or iron, and also to the hulls of ships. It forms a perfect covering, dries rapidly, and takes an agreeable lustre susceptible of receiving, by means of chemical agents, the tone of bronze, bright or dark, verd-antique, or Florence green, which has never before been communicated to pure copper. Ornaments in brass or statues in plaster, when painted in this manner, lose none of their most delicate details, and they assume completely the appearance of objects in bronze. Even statues in plaster appear to resist remarkably inclement conditions of the atmosphere. Oudry has recently mingled with his glazing colors having a basis of lead, zinc, or other substances commonly used for painting buildings, and he has learned that this substitution may be made with advantage. Painting with the glazing, which at Paris they call *metallic painting* because it contains a small quantity of porphyrized copper, dries

more rapidly than the old kind of paint, after the second day it ceases to emit any odor, and furthermore it presents a very fine grain and shines with vivid brightness. Since by reason of the discovery of nitro-benzine and aniline the price of benzine has considerably advanced, Oudry has commenced to use instead the mineral oil which Canada and Pennsylvania send to Europe in such great quantities. This new employment, if it becomes general, cannot fail to dethrone oil of turpentine and the drying oils.

By mixing the powder of galvanoplastic copper with certain fatty oils, Oudry obtained very beautiful greens of varied hues.

Oxygen Gas to counteract Gangrene.—In our last communication we referred to the satisfactory results obtained by the use of carbonic acid gas in the treatment of obstinate ulcers. In the Hospital *Hotel Dieu* at Paris, experiments have been made which induce the belief that it is possible to cure gangrenous limbs by exposing them to an atmosphere of oxygen. The following circumstances have led to these experiments. Quite recently a young physician, in a thesis submitted to the Faculty of Medicine, put forth this opinion that "*Gangrene consisted essentially in the diminution or absence of the oxygen necessary to the integrity of the life of a tissue.*" The author of this proposition, Maurice Raynaud, deduced it from chemical analyses of gangrenous parts.

Upon this conclusion, Dr. Laugier, Surgeon-in-chief at *Hotel Dieu*, bases the treatment under consideration. At the very time when he read the thesis of Dr. Raynaud, he had a case of spontaneous gangrene under his care at *Hotel Dieu;* the idea occurred to him to expose the gangrenous parts to an atmosphere of oxygen. The patient was 75 years of age; the disease was seated in one foot, one toe being already mortified; the skin upon the small part of the foot was painful and altered in color, and the foot itself even in danger of destruction. The member was placed in a simple apparatus which was arranged to disengage oxygen continuously without requiring to be renewed. In a very little time, says Dr. Laugier, the gangrene was arrested, and the parts menaced returned to a healthy state. The eschar upon the toe disappeared little by little, a cicatrix formed and the disease was cured.

A second experiment was made in the same hospital upon another patient also 75 years of age. A rapid change took place in the condition of the ulcer which promptly advanced to a cure.

If these facts are confirmed in other cases of spontaneous gangrene, this observation will prove of great service to humanity, and a new proof of the advantage to physicians from the pursuit of chemistry. The following fact, taken from the works of French physicians, shows that what is here claimed for chemistry may also be affirmed of natural history.

Treatment of Tubercular Leprosy, or the Red Disease of Cayenne.—About 30 years ago, Dr. Guyon, residing in a tropical country, was a witness of the liveliest anxiety of a family in which the elder son, from ten to twelve years of age, became affected with tubercular leprosy developed spontaneously. A son and a daughter still remained to the parents. Dr. Guyon, having been requested to examine the young patients, recognized upon their little bodies indications of the dreaded disease. These indications consisted in rose-red spots upon the skin,

with insensibility. This was the *red disease of Cayenne*, the first stage, within the tropics, of tubercular leprosy. As he was reminded of this terrible disease, Guyon advised to remove the young patients from the influence of the climate, and to send them as soon as possible to France, basing his opinion upon a well known fact in natural history.

The *Red Disease of Cayenne* is said to be a product of the country: it ought therefore to happen with this disease as with plants of the same country, the seeds of which when transported to France do not develop, although some of them may germinate.

The afflicted family were in affluent circumstances, and their decision was soon formed, they settled their affairs and removed to France. This took place in 1826, and what was the result? Just what had been anticipated. The disease was not indeed healed, for the marks which already existed remained as they were; but its progress was arrested and the spots did not increase in extent. Becoming adults, the two young people were married, and both had children, of both sexes, without the occurrence of anything extraordinary in regard to the health of either.

Preservation of Wood.—It has long been known that wood may be preserved by carbonizing its surface, and in the country this method is generally adopted when piles or posts are planted in the earth, because that wood thus treated very completely resists the action of both air and water. At the commencement of the present century, Berthollet proposed to carbonize the interior of casks designed to contain portable water for the use of mariners, but he did not succeed in any prompt and sure method of effecting this carbonization in a uniform manner. Such a method has now been discovered and its application in government vessels is commenced.

The process of Mr. de Lapparent, consists in directing, against the surface of wooden structures to be preserved, a jet of inflammable gas which burns the wood to the depth of about one fourth of a millimetre. The operation is performed in the interior as well as the exterior of casks after they are entirely set up and ready to be cased.

[The jet which is best adapted to this purpose is that known as Daniell's jet, the coal gas being in the exterior envelope, and the air from a smith's bellows being blown through the interior pipe. I have repeated Mr. Lapparent's process with satisfaction, and have advised its adoption in the American iron clad Navy.—s.]

In localities where illuminating gas is not available Lapparent recommends to use the "*water gas*," obtained by passing a current of vapor of water over incandescent charcoal, which burns by depriving the water of oxygen and gives off hydrogen and oxyd of carbon, which in the absence of a gasometer are conducted directly to the point where the charring of the wood is to be performed.

An idea may be obtained of the economy of this application from a consideration of the fact that war vessels require for repairs of water casks after five years' service $\frac{1}{24}$ of the cost of their construction.

The Orleans railroad company have already applied this process to the preservation of railroad-ties. 20 kilometers of such ties have already been laid down, and we shall soon learn the results. Finally,

the government of Holland have made use of the same process for carbonizing timbers 5 or 6 metres in length, designed to be buried in the earth for strengthening the dykes, which in that country require continual repairs.

The Ceramic Arts of the London Exhibition.—For the following review we are indebted to Mr. Salvètat, director of the manufactory of Sèvres, and member of the Jury of the Exhibition. One general fact, he remarks, is presented by the Exhibition of 1862, and this fact is observed in the ceramic products as well as in very many others.

France, skillful in details, does not possess that happy talent for practical application which we observe in the Anglo-Saxon race, with their abundant resources, perfect workmanship, admirable fabrics, and industrial organization. But we find in England few of the novel ideas of which such a suggestive collection is crowded into the Ceramic Courts of the French.

In the French department, we find numerous exhibitors who, in different ways, are engaged in producing ornamental ceramic objects by the application of fine arts to manufactures, but they are deficient in certain practical notions of technology so fully developed by English manufacturers. Artistic taste has however increased in a surprising manner in England since the Exhibition of 1851. Messrs. Minton, Copeland and Wedgewood, have shown with what rapidity change is possible in that country which some have represented as entirely destitute of artistic tendency.

Some improvements which French industry has introduced into the ceramic art are worthy of mention.

To the Imperial manufactory at Sèvres is due the development of processes by the aid of which objects are formed of an entire piece in colored porcelain mass decorated at a high temperature without repeated bakings.

The number of metallic oxyds which it is possible to introduce into the mass has, as a consequence, considerably increased, and substances have been added capable of correcting the excess of fusibility of the clays thus colored. Again, it has been found that the action of the oxygen in flame and of the products of incomplete combustion modifies the shade of the clays, and produces with one and the same material very different colors. Thus, with the oxyd of chromium in a reducing atmosphere a blue shade is obtained, while with an oxydizing atmosphere a green color is produced, showing ruby red in the light. With the oxyd of uranium, in an oxydizing atmosphere, a pure yellow is brought out, and hues varying from reddish brown to black in the reducing atmosphere.

I would also call attention to the successful efforts made in the manufactory of Bordeaux to replace the old potter's wheel by mechanical means.

The art of brilliant gilding, whereby the cast leaves the mould with a metallic lustre without recourse to burnishing, has been largely developed at the hands of its discoverers, the Messrs. Dutertre. The discovery of other metallic lustres made by Messrs. Gillet and Brianchon; the application of chromo-lithography to the decoration of pottery; the employment of a vacuum, or of compressed air, to obtain perfect impressions in moulds, are equally interesting results, honorable to French industry.

"The employment of chromo-lithography appeared, it is true, in the exhibitions of Spain and of the Zollverein. But it should be stated that at Seville it was introduced under a license from a French patent, and that in Germany the specimens exhibited showed the application of the art to be in a rudimentary condition."

Mr. Salvètat remarks also that the English exhibitors have produced a new ceramic composition which is a perfect imitation of ivory. The process of its manufacture has not been made known.

Bibliography; Recent publications by HACHETTE & Co., Paris.

Leçons de Chimie et de Physique Professées en 1861 *à la Société Chimique de Paris.*—These lectures belong to the series which we noticed last year, and they have met with the same success, for the lecturers have treated only of subjects in which they have made extensive researches and important discoveries. The following are the subjects treated:

On the fusion of platinum and the production of high temperatures; by Mr. Debray (the associate of St. Claire Deville).

On the optical study of sound; by Mr. Lissajous.

On nitrification and uses of nitrates in vegetation; by Mr. Cloës.

On the luminous effects resulting from the action of light upon different bodies; by E. Becquerel.

On the organized corpuscles which exist in the atmosphere; being an examination of the doctrine of spontaneous generation; by Mr. Pasteur.

Entretiens Populaires à L'Association Polytechnique; 2nd series, 1862, in 12mo. This volume contains a series of lectures delivered by Babinet upon the physics of the globe.—Geoffroy St. Hilaire, upon acclimation.—Bouchardat, upon the abuse of fermented drinks.—Perdonnet, upon great inventions.—Homberg, upon the bleaching of linen.

Bréguet.—Manuel de Télégraphie Electrique, 4th edition, 1 vol. in 12mo, with figures, 1862. This volume is divided into four parts. The *first* contains the principles of Physics indispensable to the study of telegraphy. The *second*, the arrangement of the apparatus most frequently employed. *Third*, the study of telegraph lines, aerial, subterranean and submarine. *Fourth*, applications of electricity connected with electric telegraphy, such as electric clocks and domestic annunciators.

Mr. Bréguet, who is a member of the Bureau of Longitude, has under his direction all that relates to electric telegraphy, and to accurate apparatus in which electricity plays a part; his book has therefore an importance perfectly legitimate.

Mayer et Pierson.—La Photographie considérée comme art et comme Industrie. 1 vol. in 12mo. Mayer and Pierson are the photographers who by their beautiful works have recently caused it to be decided that *photography is an art*, and that therefore it has in its sphere the same claim as the painter at his canvass and the sculptor at his statue. Their book does not give all the details of the photograph business, but it gives definite directions in regard to the manner of placing objects in such a manner as to make them appear to advantage. They also give interesting details of the early history of photography and its relation to Daguerre and Niepce, and finally they close with the history of the grand civil suit which resulted in giving aid to photography and in causing photographs to be received in the exhibition of works of art.

Aug. Dupeyrat.—Canal Maratime de Junction de l' Ocean à la Mediterranie, a brochure in 8vo.—Here is the complete realization of an idea of the 17th century, to wit: to unite Bordeaux to the Mediterranean, so that ships of large tonnage may be relieved from the necessity of going around Spain by way of the Straits of Gibraltar. This idea is now important as following the cutting through of the isthmus of Suez, and will thus serve to bind together the West and the Orient.

Ach. Fillias.—Geographie Physique et Politique de l' Algerie. 1 volume in 12mo.—This work, which gives important details of statistics, closes with a geographical and historical dictionary of all the localities belonging to this French province.

Sédillot.—Histoire des Arabes, a volume 12mo with one plate. The subject of Algeria is ably treated in this book, in which the author proves that the Arab race was much better fitted for the pursuit of mathematics, geography and astronomy than the Hindoos or the Chinese; he has taken this nation at its origin, and has studied it with care in the different phases of its existence.

Ladevi-Roche—Unité des Races Humaines, a brochure in 8vo. The author decides in favor of this unity, after a profound examination of the moral nature of man in connection with an examination of physical facts which have been demonstrated by different observers.

Ch. Musset.—Hetérogénie ou Génération Spontanée, in 4to with plates. Mr. Musset is a great partisan of spontaneous generation, which he supports by observations which he has made with care in common with Joly of Toulouse.

By H. Bossange, Quai Voltaire, 25, Paris.

Achille Delesse.—Carte Agronomique des Environs de Paris, 1862.—For some time past they have undertaken, in France, to represent the vegetable world and its composition by special charts called *Cartes Agronomiques*. The chart which Delesse has made of the environs of Paris has a special interest because it makes known more completely the Parisian soil recently so deeply explored for the sake of the quarries of building stone which it contains. One peculiar feature of this soil is that the quarries are all in the valleys or upon the slopes of the hills, while the tops of the hills are sandy. The three elements of arable soil, the calcareous, the clayey, and the sandy, are largely represented in the soil of Paris, while the proportions vary considerably. These proportions are clearly shown in the chart of M. Delesse by the aid of well selected colors. [We acknowledge the reception of this brochure from the author.—*Eds.*].

Bigwyer de Chancourtois.—Vis Tellurique.—This work consists of a natural classification of simple bodies as well as of organic radicals, effected by means of a system of 'helicoid' and numerical classification. This classification which depends especially upon the physical properties of bodies, conduces, very frequently, to results which accord with chemical observations. It was thus that the place of rubidium was marked upon the helix of M. de Chancourtois before that he knew the physical properties of this metal; so also the simple bodies which we have named semi-metals (*Journal de Pharmacie*, xl, p. 23) and which as we have seen form a class by themselves, appear in the table of M. de Chancourtois under the name of intermediate bodies, results to which M. de Chancourtois has been led from considerations totally different from our own. The same considerations led him to double certain equivalents, such as C, O, S, Se, Te, &c., just as has been done in the notation of Gerhardt. These parallel coincidences are certainly not accidental, they reveal a fundamental law of which the "*vis tellurique*" appears to give the key.

A. Scheurer-Kestner.—Principes Elémentaires de la Théorie Chimique des Types Appliquée aux Combinasions Organiques.—The leisure imposed by a political imprisonment has given to the author, a young chemist full of ardor, the idea of making for the chemical theory uppermost in his mind a sort of catechism for the use of persons who desire to become acquainted with this theory, deduced from the labors of Laurent and Gerhardt, of Dumas, Wurtz, Hoffman, Williamson, T. Sterry Hunt, &c. This theory is explained with great clearness and supported by numerous examples.

Boussingault.—Agronomie, Chimie Agricole et Physiologie, tome II.—This second volume is occupied for the most part with the great question of nitrification, and the assimilation of nitrogen by plants. All these questions are examined with the well known talent of Boussingault, and all lead invariably to this conclusion, that if plants derive nitrogen from the atmosphere it is not taken up in the form of nitrogen gas. Upon this subject the author cites numerous observations made by Messrs. Lawes, Gilbert, and Pugh.

H. Laurent.—Theorie des Séries.—The name of the author and the title of the work, lead one to suppose that he refers to the homologous series; this is an error. The work is devoted to mathematical analysis and the application of this theory to the calculus of transcendental expressions. It was at the polytechnic school, which he he has left, that M. H. Laurent composed this valuable work. Our readers will learn with pleasure that this young mathematician is the son of Auguste Laurent, the great chemist, whose biography we have given in this Journal, ([2], xvi, p. 103).

J. Nicklès.—Theorie Physique des Odeurs et des Saveurs. A brochure in 8vo, 1862.—The author has taken the idea of this work from what has been previously stated, (this Journal, [2], xxviii, p. 427). This question, at once so interesting and so little studied, has in the new work been thoroughly examined upon theoretical considerations and also experimentally.

3. *Correspondence of* T. Sterry Hunt, F.R.S. (In a letter to the Editors, dated Montreal, February 1, 1863.)

Gentlemen,—You have given, on page 113 of this volume, an abstract of Schönbein's and Böttger's important observations upon the formation of a nitrite with ammonia, at the expense of water and atmospheric nitrogen. May I beg of you, as an important part of the history of this subject, and especially as an explanation of the theory of the reaction, to reproduce from the *L. E. and D. Philos. Magazine* for January, 1863, the following translation of a note *On the nature of Nitrogen, and the theory of Nitrification*, read by me before the French Academy of Sciences, on the 15th of last September, and published in the *Comptes Rendus* of that date (p. 460). My object is to claim for myself the new theory of nitrification, which Schönbein seeks to found upon his recent experiments, and which I published nearly two years since. It is in reality but a natural deduction from my view of the double nature of nitrogen, as the nitryl of nitrous acid, which I have maintained since 1848.

I am not aware whether my announcement of the production of ozone from permanganic acid, a discovery which is claimed both by Schönbein and Böttger, is anterior to that of the last named chemist. My own notice of it, which appeared in this Journal for July 1861, (vol. xxxii, p. 109) was dated and sent to you in Jan. 1861. (You are aware that the date of 1860, there assigned to it, is a printer's error.) The observation however has not the merit of great originality, for I was led to it by a remark in *Gmelin's Handbook* (Cavendish Soc. Ed., iv, p. 211) published in 1850, where Forchhammer's remark, that permanganic acid evolves "an electrical odor," is cited, with a suggestion that this may be due to ozone.

In two notes to my paper on petroleum (this vol., pp. 158 and 162), I have had occasion to call attention to my long since published views, on the equivalents of carbon, oxygen, etc., and on the constitution of gelatine and the albuminoids. These, after many years, are being resuscitated, and, like my theory of chemical types, are making progress in the scientific world. In this connection I may be permitted to express my satisfaction that the Kantian doctrine of the interpenetration of matter, which I set forward ten years since, as lying at the basis of a true chemical philosophy, is finding an exponent in Mr. Charles Peirce, whose paper on *The Chemical Theory of Interpenetration* appears in the last number of your Journal. See, on this subject, my paper *On the Theory of Chemical Changes*, which appeared in this Journal for March, 1853, (vol. xv, p. 226,) and was reproduced in the *L. E. and D. Philos. Magazine*, and in a German translation in the *Chem. Centralblatt*. See also my *Thoughts on Solution*, (vol. xix, p. 100), where, while still asserting interpenetration, I say that Kant's definition of chemical union "involves a mechanical conception, and is therefore inadequate. That of Hegel, in which chemical combination is said to be an identification of the different, is however completely adequate. His process involves an identification not only of volumes, (interpenetration, mechanically considered,) but of the specific characters of the combining bodies." See this doctrine taught by Stallo, *Philosophy of Nature*, p. 87. See also my objections to the Atomic hypothesis, in a note *On Atomic Volumes*, read before the

French Academy in 1855, (*Comptes Rendus*, xli, p. 77). The mechanical and material hypothesis, which belong to the infancy of the chemical and physical sciences, are gradually being repudiated, and these sciences themselves placed upon a philosophical basis. I shall be happy to believe that I have contributed to spread more just philosophical notions among modern chemists.

"In 1848 I suggested that free nitrogen is the nitryl of nitrous acid, NHO_4, $NH_3 - H_4O_4 = NN$, corresponding to the nitric nitryl, NNO_2, and to the phosphoric nitryl, PNO_2 (*American Journal of Science*, [2], v, 408; vi, 172; viii, 375). It might then be supposed that, like these two bodies, nitrogen should under favorable conditions fix H_4O_4, and regenerate nitrous acid and ammonia. In April 1861, I published a note in '*The Canadian Journal*' of Toronto, in which it was said that the spontaneous formation of these two bodies, by the combination of atmospheric nitrogen with water, would serve to explain the production of ammonia, so often remarked in the presence of air and reducing agents, and also the formation of nitrates in the experiments of Cloez, without the intervention of ammonia, and at the expense of air and water in presence of alkaline matters (*Comptes Rendus*, lxi, p. 135).

The simultaneous production of ozone and an acid of nitrogen by the electric spark, and during the slow oxydation of phosphorus, may be explained by the power of active oxygen to oxydize ammonia, thus setting free the acid of a small portion of regenerated nitrite of ammonia, and even, in accordance with the observations of Houzeau, carrying its oxydizing action so far as to acidify the nitrogen of the atom of ammonia. Certain of the reactions attributed to ozone would thus, as many chemists have already maintained, be due to a minute portion of nitrous acid, which is formed when active oxygen is brought in contact with moist atmospheric nitrogen. On the other hand, the hydrogen set free by reducing agents may, by destroying the acid of the regenerated nitrite of ammonia, set free the ammonia of the salt, and even form a second atom by the reduction of the acid (*The Canadian Journal*, March 1861). These views will also be found in a note written by me, and published in the *American Journal of Science* for July 1861 (page 109), and copied into the *Philosophical Magazine* for September 1861, and the '*Chemical News*.' I found that a current of air, which had passed through a solution of permanganate of potash acidulated with sulphuric acid, acquired the odor and the reaction of ozone. This disappeared when the air was passed through a solution of potash, which at the end of a certain time appeared to contain a nitrite. This reaction, which seems to indicate the formation of nitrous acid, not by an electric or a catalytic action accompanying the production of ozone, but by the action of nascent oxygen upon atmospheric nitrogen in the presence of water, supports the above views, and, as I have remarked in the note in question, furnishes the key to a new theory of nitrification.

The formation of nitrite of ammonia, by the combination of the nitryl NN with H_4O_4, must necessarily be limited to very minute quantities by the instability of this ammoniacal salt, which, as is well known, decomposes readily into nitrogen and water. In order therefore to produce any considerable quantity of a nitrite by this reaction, there is required the presence of active oxygen or of a fixed base to separate the ammonia.

The recent experiments of Schönbein have furnished new evidences of the direct formation of a nitrite at the expense of the nitrogen of the atmosphere. According to him, when sheets of paper moistened with a feeble solution of an alkali or an alkaline carbonate are exposed to the air, especially in the presence of watery vapor, and at a temperature of 50° or 60° C., the alkaline base soon fixes a sufficient quantity of nitrous acid to give the characteristic reactions. Appreciable traces of nitrite are, according to Schönbein, obtained in this way even without the intervention of an alkali. He more-

over found that distilled water, mixed with a little potash or sulphuric acid, and evaporated slowly at a temperature of 50° C. in the open air, fixes in the one case a small portion of ammonia, and in the other a little nitrous acid. Traces of a nitrite are also formed in pure water under similar conditions. Schönbein explains all these results by the combination of nitrogen with the elements of water, producing at the same time ammonia and nitrous acid. As he has well remarked, this reaction serves to explain the absorption of nitrogen by vegetation, and, through the oxydation of nitrites, the formation of nitrates in nature. By these elegant experiments, he has confirmed in a remarkable manner my theory of nitrification, and of the double nature of free nitrogen. It is however evident that, since the publication of my note of March 1861, referred to above, we cannot say with Schönbein that the generation of nitrite of ammonia from nitrogen and water is "a most wonderful and wholly unexpected thing." (Letter from Schönbein to Faraday, *Philosophical Magazine*, June 1862, p. 467.) I cannot, however, admit with these gentlemen that the results of Schönbein are due to evaporation, except in so far as the coöperation of water and a slightly elevated temperature are necessary conditions of the reaction."

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY.

1. General Chemistry.

1. *Thallium*:—Dumas read before the French Academy, on the 15th of December, an elaborate report on the memoir of Mr. Lamy upon *Thallium*. This report, read, as Abbé Mogrio says, "*au milieu du plus profond silence*," is so important and interesting that we print it in full, from the translation in the *Chemical News* of Jan. 10th.

"*Report on a Memoir of Mr. Lamy relating to Thallium;* by Mr. Dumas.[1]—At the origin of human societies, the arts of procuring fire at will, of cultivating corn, of extracting metals, were considered benefits so great that the inventors of these arts were ranked among the gods.

At the present day, the metals are so numerous that the discovery of a new simple body of this class is less astonishing to ordinary men, although the scientific interest attaching to the discovery has not at all diminished. So far from that, in proportion as new metals are pointed out, the characters which appertain to them throw, by comparison, a strong light on the characters, similar or opposite, which are found in the older metals.

As soon as the bold and felicitous labors of Bunsen and Kirchhoff had shown, beyond doubt, that, in studying natural products by spectrum analysis, it was possible to discover traces of metals which ordinary analysis was powerless to recognize, rubidium and cæsium were considered by all chemists as only the two first terms of a long series of new elements. Every one understood that the residues of manufactures, in which, by the elimination of known and useful products, were concentrated the inappreciable traces of useless and unknown substances that the matter originally worked sometimes contained, offered a mine worth exploring.

It was, therefore, natural enough that Mr. Crookes in England, and Mr. Lamy in France, should submit to spectrum analysis the products of the combustion of iron pyrites, which for some years have played such an important part in replacing sulphur in the manufactare of sulphuric acid; and it is easy to understand, when one has seen it, that the beautiful green line, produced in the spectrum by the new body which forms the subject of this report, could not have escaped the observation of either the one or the other.

[1] *Comptes Rendus*, lv, p. 866.

But, in our opinion, it is neither the process by which the new metal was recognized, nor the material which furnished it that commends it to our notice. Spectrum analysis has completed its proofs, and manufacturing residues have long since been recognized as fruitful mines to explore. But thallium is destined to mark an epoch in the history of chemistry by the astonishing contrasts exhibited between its chemical characters and physical properties. It is no exaggeration to say, that, in regard to the classification generally accepted for the metals, thallium offers an assemblage of contradictory properties which entitles it to the name of a metallic paradox—the ornithorhynchus of metals.

We shall not detain the attention of the Academy on the history of its discovery. No one disputes that Mr. Crookes first saw, on the 30th of March, 1861, the green line characteristic of thallium in certain selenium residues; that he recognized it again in the products of a specimen of sulphur from Lipari, and in those of a pyrites from Spain; and that he described and named thallium as a new simple body.

Nor will any one dispute that Mr. Lamy was the first to isolate thallium, and establish, in the sequel, that it was not a metalloid analogous to selenium and tellurium, as Mr. Crookes, who had never obtained it free and pure, thought; but that it was, in fact, a true metal. Mr. Lamy announced his discovery to the Société Imperiale of Lille on the 16th of May, 1862, and on the 10th of June he submitted to the jury of chemists in London, in the presence of Mr. Crookes, a beautiful ingot of thallium. If the latter gentleman considered that he had any rights to preserve, he should at once, as is usual in such cases, have taken the members of the jury to his laboratory, and exhibited his notes and his products, instead of silently listening to the communication of Mr. Lamy, and depositing at the Royal Society, eight days afterwards, a note indicating that he had long been aware of the metallic nature of thallium, and was acquainted with the essential properties of the new body.

The historical point which engages us—for, in chemistry, the discovery of each new simple body has its legend or its history—is determined by two authentic dates; one of these is the 30th of March, 1861, on which day Mr. Crookes announces the existence of a new body which he believes to be non-metallic, characterized by the brilliant green line: the other is the 16th of May, 1862, the day on which Mr. Lamy makes known the metal as a metal, and who alone possesses it.

It was in the sulphuric acid manufactory of our learned *confrère*, Kuhlmann, among the sediment of the leaden chambers fed by Belgian pyrites, that Lamy discovered thallium in tolerably large quantity, and in a form which made it easy to extract; for, by a little manipulation, it could be brought to the state of sulphate or chlorid, from which combination the metal itself can be easily separated by means of zinc, which takes its place, and precipitates it in crystals, in the same manner as lead.

The Academy will permit us to draw attention to the importance which attaches, in cases of this kind, to positive characters, like those given by spectrum analysis. We shall see, as we proceed, that, beyond his certain conviction and natural penetration, a sure guide was necessary to Mr. Lamy, to prevent him from going astray in the first steps of the study. In fact, if the green line had not been there to prove incessantly that he was not dealing with lead or a plumbiferous alloy, how many chemical reasons were there for thinking that such was the fact! This metal, which is separated like lead from solutions of its salts, by means of zinc, presents the appearance of lead. It has nearly the same color as lead; is scratched and cut like it. It makes a streak on paper like that which lead produces; it has the same density, and and very nearly the same melting point. It possesses the same specific heat. Its solutions are precipitated black by sulphuretted hydrogen, yellow by iodids and chromates, and white by chlorids, just as those of lead are. We do not then hesitate to assert, that, without the aid of spectrum analysis, this curious and important metal must have remained unrecognized; that, even with this

help, it was easy to be mistaken; and that Mr. Lamy has given proofs of great sagacity, when he places, without hesitation, a metal so much resembling lead in its essential properties beside the alkali metals, potassium and sodium, which it resembles so little.

Thallium is a perfect metal, endowed in the highest degree with a metallic lustre, as is seen on examining a freshly-cut surface, or on heating a bar strongly in hydrogen, and allowing it to cool in that gas. It is less blue than lead, less white than silver, and, in its color, more resembles tin or aluminium than any other metal. It softens at 100° C., and, if kept for some time at that temperature, a crystalline structure becomes apparent in the ingot: this is shown by the appearance of a beautiful watering (*moiré*), produced when the metal is moistened with water, which cleanses the surface like acids.

Before the blowpipe, thallium exhibits some characteristic phenomena. It melts rapidly, and oxydizes, giving off odorless fumes, of a whitish color, but mixed with reddish or violet tones. It continues to give off the fumes a long time after the heating has ceased. When the principal globule has cooled, it is found to be surrounded with small globules of the volatilized metal. In a closed tube, it melts in the flame of a spirit-lamp, oxydizes rapidly, giving an oxyd which, when hot, calls to mind the appearance of rubies (metallic sulphids), and when cold more resembles litharge: this is a compound of the protoxyd of thallium with the silica of the glass. A globule of the metal, heated over a spirit-lamp in a bulb tube open at both ends, and inclined to facilitate the passage of air, soon melts, forming a layer of the ordinary brown fused oxyd, but, at the same time, giving off abundant fumes, which condense, a short distance from the bulb, as a reddish or violet amorphous powder. When a globule of the metal is placed on a cupel heated to redness, and then plunged into oxygen, the metal burns brilliantly, and oxydizes, the fused oxyd sinking into the cupel. This oxyd is either the peroxyd of thallium, or a mixture of the proto- and peroxyd of thallium.

Mr. Lamy has discovered that thallium forms two oxyds: the protoxyd, a strongly alkaline base, like soda and potash; and the peroxyd, which gives up oxygen when heated with strong acids, and may be converted into a chlorid, which, when heated, gives up a part of its chlorine. Chemists, however, will notice that the protoxyd of thallium, which corresponds to potash, so far from having, like potash, a great affinity for water, loses its water readily when heated, or even when cold in a vacuum. There then remains the reddish anhydrous oxyd while the hydrated oxyd is yellowish white: the oxyd is hydrated or dehydrated with equal facility. It will be further remarked, that the peroxyd of thallium, in the experiments of Mr. Lamy, has given no sign of the formation of oxygenated water.

Thallium burns in dry chlorine. It forms three chlorids, one of which corresponds to common salt, another to sesquichlorid of iron, while the third is a bichlorid corresponding to corrosive sublimate. The protochlorid is white, fusible, slightly soluble, and, when prepared in the moist way, is precipitated in large dense flocculi like chlorid of silver. Thallium can also form higher chlorids than the bichlorid, but their composition is not definite.

Only the proto-iodid and proto-bromid have been studied; they resemble the corresponding compounds of lead. Cyanid of thallium is soluble; but a crystalline precipitate of this salt is formed when concentrated solutions of cyanid of potassium and of a salt of thallium are mixed.

The sulphid of thallium obtained by precipitation is brownish black; it resembles sulphid of lead. In whatever way obtained, it easily oxydizes in the air, and is converted into the soluble and colorless sulphate.

Thallium is very slowly attacked by hydrochloric acid even when concentrated and boiling. It is, on the contrary, rapidly attacked by nitric and sulphuric acids. The latter, concentrated and hot, dissolves it with a rapidity which contrasts with the slowness with which the same acid attacks lead.

In relation to the action of acids, thallium presents a complete opposition of

characters to aluminium, the latter being quickly dissolved by hydrochloric acid, which does not attack the former, and resisting nitric acid, which easily dissolves thallium.

In the state of protoxyd, thallium forms soluble and crystallizable salts with carbonic, nitric, sulphuric, and phosphoric acids. The carbonate is a very characteristic salt.

The salts formed by the protoxyd of thallium with organic acids, which have been studied by Mr. Kuhlmann, Jun., are the oxalate, binoxalate, tartrate, paratartrate, malate, citrate, formiate, acetate, and some others of less importance. All these salts are soluble, and, according to Mr. La Prevostaye, some of them are isomorphous with the corresponding salts of potash.

Thallium, then, is a new metal well characterized. It is distinguished from all other reputed simple bodies by the beautiful green line it gives in the spectrum, and which corresponds to the line 1442 in the typical spectrum of Kirchhoff. From the examination of the solar spectrum, we may conclude that thallium does not exist in the solar atmosphere.

Thallium undoubtedly forms one of the family of alkaline metals, the number of which has been doubled by recent discoveries. At the beginning of this century, only two of these metals were known, potassium and sodium. Forty years ago lithium was added to the number; and within the last three years three others have been discovered, rubidium, cæsium, and thallium, all three by spectrum analysis.

From this we may be allowed to hope that the number of these metals, and of metals in general, is destined, by the application of this new method of analysis, to receive a rapid and considerable extension.

Among alkaline metals, thallium occupies the opposite extremity of a scale of which lithium forms the first term, and the equivalent weights mark the different degrees. The weights are, in fact, as follows:—

Lithium,	7
Sodium,	23
Potassium,	39
Rubidium,	85
Cæsium,	123
Thallium,	204

On this point it has been remarked,—

1. That the equivalent of sodium is exactly the mean of the equivalents of potassium and lithium: $\frac{39+7}{2}=23$;

2. That by adding double the weight of sodium to the weight of potassium, we obtain the weight of rubidium: $46+39=85$;

3. That by adding twice the weight of sodium to twice the weight of potassium, we get nearly the weight of cæsium: $46+78=124$;[2]

4. That by adding double the weight of sodium to four times that of potassium, we obtain nearly the equivalent of thallium: $47+156=202$.

These considerations are of a nature to attract the attention of chemists; and without attributing to them a value that the actual numbers would not justify, they show the interest which attaches to the careful comparison of the equivalents of bodies belonging to the same family.

The alkaline metals have this peculiarity, that to bring them under the law of Dulong and Petit—that is to say, to make their atomic heats equal the atomic heats of other metals,—it is necessary to halve their atomic weights. Thallium does not escape this rule. Its equivalent =204; but its specific

[2] The new weight of *cæsium* (=133) obtained by Johnson and Allen (this vol., p. 94) does not support the combined numbers above given by Dumas. But if we add twice the weight of sodium to the weight of rubidium we have approximately the weight of cæsium: $46+85=131$.—Eds. A. J. S.

heat, as determined by M. Regnault (who appends a note on this subject to this report), being equal to 0·03355, it is necessary to reduce the atomic weight to 102. In the same way as potash has for its atomic formula K_2O, the protoxyd of thallium would have for its formula Tl_2O.[3]

The atomic volume of thallium will be equal to 8·5; and if we do not compare it with the volumes of sodium and potassium, it is because these present extraordinary anomalies which have not yet received sufficient attention from chemists.

In conclusion, we may remark that the series of alkaline metals actually known contains a body which possesses so light an equivalent that it may be placed near to hydrogen—that is to say, lithium; and also a body, thallium, which has so heavy an equivalent that it may be ranked by the side of bismuth, a metal which possesses the highest of equivalents.

We see that the discovery of new bodies extends the circle of our knowledge, not only by the facts with which they enrich practical science, but especially on account of the prospects revealed by the study of them, the laws they lead us to ascertain, and that freer and more general aspect under which we are taught to regard the properties of individual substances, their analogies, differences, and classification, and even their nature and essence.

For these reasons, and taking into consideration the difficulties overcome by the author, and the clearness and importance of his results, we have the honor to propose to the Academy that his memoir form part of the '*Recueil des Savants Etrangers.*'"

[In answer to the charges of a dishonorable character against Mr. Crookes contained in this Report, that gentleman replies as follows, giving also his grounds of priority.[4] Mr. Crookes' temperate and manly defense, under the peculiarly aggravating character of the assault made upon him, is worthy of all praise, and he certainly appears to free himself completely from the unworthy motives and practices attributed to him.—Eds.]

"*The discovery of the metal Thallium.*—In another part of this Number we print at length a translation of the report by Mr. Dumas on Mr. Lamy's latest observations on thallium. Our readers will hardly expect, interested as we are in this subject, that we should publish this report without comment. It will be seen that Mr. Dumas claims for Mr. Lamy the discovery of the *metal* thallium. Mr. Le Verrier had already made the same claim for Mr. Lamy in the journal *La France* for October 22, 1862; and, in reply to a letter of our own in answer to Mr. Le Verrier, published in the *Cosmos* for December 5, 1862, Mr. Lamy has since advanced the same claim for himself.

Now, as Mr. Lamy states (*Cosmos*, December 19, 1862, p. 681) that it is "priority of publication which constitutes priority of invention," we are induced to give a short *résumé* of dates in support of our own claim to the discovery—not only of the new element, but of its metallic character. Our readers will remember that it was in the Chemical News for March 30, 1861, we first announced "*The Existence of a New Element*, probably *of the Sulphur Group.*" The word *probably* is here of some importance, as showing the doubts we had at the time of the exact nature of the new body—doubts which were further indicated in

[3] Mr. Dumas persists in using the symbol "Th," which we have already shown has been adopted for Thorinum.

[4] Chemical News, No. 162, p. 13, Jan. 10, 1863.

the title of our next paper—"*Further Remarks on the* SUPPOSED *new Metalloid*," in the CHEMICAL NEWS for May 18, 1861. Subsequent research soon proved to us that thallium was, in fact, a true metal, but the publication of this discovery was deferred.

Mr. Lamy's claim for priority of publication, and, consequently, priority of discovery, as advanced by himself, is founded on a communication made to the *Société Imperiale des Sciences, de l'Agriculture, et des Arts*, of Lille, on May 16, 1862. On May 1, 1862, however, the International Exhibition opened, and there, in a case, deposited some days before, and open to the inspection of the numerous scientific men of all countries who were present on the occasion, was displayed several grains of the new body, with the following label—'*Thallium, a New* METALLIC *Element, discovered by means of Spectrum Analysis.*' Besides this there was a card, on which was written '*Chemical Reactions of Thallium, by which it is distinguished from every other known element. It appears to have the character of* A HEAVY METAL, *forming compounds which are volatile below a red heat. It is reduced from its acid solution by zinc in the form of a dense black powder, difficultly soluble in hydrochloric acid, readily soluble in nitric acid.*' The above, we contend, was a publication in the widest sense of the word, and in this publication the metallic nature of thallium was distinctly asserted. The metal, it is true, was exhibited in powder, just as it was obtained by precipitation by means of zinc, but was none the less the pure metal. It was there for the jury of chemists to examine if they thought proper. It was not examined chemically by the jury; no one tested it; and yet Mr. Lamy, in his letter to the *Cosmos*, has the hardihood to assert, that Mr. Crookes 'contented himself with exhibiting to the public and the international jury of Class II, as thallium, some centigrammes of a black powder which was not thallium.' We shall make no remark on this assertion of Mr. Lamy; but, as some of our readers may be inclined to ask why the metal was not exhibited in the form of a button, we shall be excused for going into some detail.

The source from which we extracted the metal, and the compounds exhibited, was sulphur from the Spanish pyrites mentioned in our paper of May 18, 1861. This sulphur contained no more than *one or two* grains of thallium in *a pound*. The metal and compounds we exhibited represented in all about twenty grains of the metal, and the difficulty of extracting this quantity from upwards of fifteen pounds weight of sulphur will be fully appreciated by all chemical readers, when we inform them that the whole of the sulphur had first to be dissolved in nitric acid. We may contrast this, in passing, with the source from which Mr. Lamy derived his metal, as described by Mr. Dumas,—namely, the residues of a sulphuric acid manufactory, 'which contained thallium in tolerably large quantity, and in a form which made it easy to extract.'

Ignorant, at the time, of any richer source of thallium, and having in previous fusions of the precipitated metal discovered that it was rapidly volatilized and lost by oxydation, as described by Mr. Dumas, it was hardly likely that we should risk the loss of the whole of our small specimen for the sake of exhibiting it in a button; it was, therefore, placed in the Exhibition in the form of powder as precipitated. We

might refer to our laboratory note-book, which is open to inspection, to prove that we had obtained the metal and fused it in September, 1861; but as a note in a private book does not constitute a publication, we found no claim on this. Nor do we on the fact that Mr. Williams saw the metal in our laboratory in January, 1862, as mentioned by him in the CHEMICAL NEWS, v, p. 350. But it may be evidence that we were 'aware of the metallic nature of thallium, and acquainted with the essential properties of the new body,' to state, that early in April, 1862, we had the following labels printed by Silverlock (as can be proved by a reference to the books of that firm) for the metal and the salts at that time we had prepared:—

Thallium (θαλλος)—Oxyd of Thallium—Sulphid of Thallium—Basic Chlorid of Thallium—Iodid of Thallium—Sulphate of Thallium—Chlorid of Thallium—Nitrate of Thallium—Ferro-cyanid of Thallium—Cyanid of Thallium—Phosphate of Thallium—Carbonate of Thallium—Chromate of Thallium—Thallium, Sublimed—Oxalate of Thallium.

It is sufficient for us, however, that the metal, labeled and described as a metal, was in the International Exhibition, at its opening, on the 1st of May, 1862, to prove priority of publication to Mr. Lamy's communication made at Lille, on the 16th of May, 1862.

The fact, that the metal was in the Exhibition, rendered it quite unnecessary for us to do what Mr. Dumas says we should have done after seeing Mr. Lamy's specimen. Our metal and two products, the peroxyd and sulphid, had been in the Exhibition some time, with the descriptive cards we have quoted; and with regard to Mr. Dumas's insinuation, that we borrowed from Mr. Lamy some, if not all, of the materials for the paper read before the Royal Society a few days after we met that gentleman, it may suffice to say, that, as Mr. Lamy only spoke French, a language we ourselves speak but imperfectly, it was not possible that either of us could have profited much by the interview.

We have no wish to detract in the least from the great merit of Mr. Lamy's researches. We estimate as highly as any one the skill and industry with which he has worked out the compounds of thallium. But it must not be supposed, as Mr. Lamy seems to suppose, that we ourselves remained idle during the fourteen months which had elapsed since we remarked the green line in the spectrum. With the limited means at our disposal, and amid other pressing occupations, we had, and have since, been continually engaged in investigating the properties and compounds of the new metal; and all we need say to Mr. Lamy is, that we heartily congratulate him on his successes, and envy him nothing but his opportunities."

2. ANALYTICAL CHEMISTRY.

2. *Alkalimetry.*—In the Sheffield Laboratory of Yale College the following method of conducting nice alkalimetrical analyses is employed, which combines several of the most recent improvements in a manner that unites great convenience with the highest accuracy. The requisites are, besides the usual graduated apparatus, a standard acid, a standard alkali, an indicator of the point of neutralization, and pure carbonate of soda.

The standard acid. The use of crystallized oxalic acid, as suggested by Mohr, has come into general favor, and nothing can be more satisfactory when the acid is *pure* and of *constant composition*. It is, however, difficult not only to procure a pure acid, but also to preserve it dry without loss of crystal-water. To dry the pulverized acid over oil-of-vitriol until it ceases to lose weight, as proposed by Erdmann, or to select uneffloresced crystals by help of a magnifier, is troublesome and likely to introduce error. We employ a dilute sulphuric acid, which may be made of convenient strength for ordinary use, by diluting ten cubic centimeters of oil-of-vitriol with water to the volume of a liter.

The standard alkali is made from commercial caustic potash: this is dissolved in water and diluted until a given volume e. g. 5 c. c. neutralizes 4 to 5 c. c. of the standard acid, as is determined by a few rough trials.

The alkali-solution thus obtained is heated to boiling in a flask, and a little freshly-slaked lime is added to decompose any carbonate of potash. The boiling is continued a few minutes and, finally, the ley is poured upon a filter, and the filtrate is collected in the bottle from which it is to be used. Care should be taken to bring upon the filter some of the excess of lime that is suspended in the liquid, so that the latter may acquire no carbonic acid from the air. The clear liquid thus obtained is a potash-lye containing lime in solution. If exposed to the air, the carbonic acid that is absorbed separates as carbonate of lime, leaving the liquid perfectly caustic.

It now remains to determine with the greatest accuracy, 1st, the volume of alkali which neutralizes a cubic centimeter of the acid and, 2d, the amount of SO_3 contained in a cubic centimeter of the latter.

As a means of recognizing the point of neutralization, tincture of cochineal possesses great advantages over solution of litmus. The knowledge of this fact is due to Luckow who has detailed its application in *Jour. für Prakt. Chem.*, lxxxiv, p. 424. Tincture of cochineal is prepared by digesting and frequently agitating three grams of pulverized cochineal in a mixture of 50 cubic centimeters of strong alcohol with 200 c. c. of distilled water at ordinary temperatures for a day or two. The solution is decanted, or filtered through Swedish paper.

The tincture thus prepared has a deep ruby-red color. On gradually diluting with pure water (free from ammonia), the color becomes orange and finally yellowish-orange. Alkalies and alkali-earths as well as their carbonates change the color to a carmine or violet-carmine. Solutions of strong acid and acid salts make it orange or yellowish-orange.

To determine the volumetric relation of the alkali and acid, a given volume of the latter, e. g. 20 c. c., is measured off into a wide mouthed flask, ten drops of cochineal-tincture and about 150 c. c. of water are added—the alkali is now allowed to flow in from a burette, until the yellowish liquid in the flask, suddenly, and by a single drop, acquires a violet-carmine tinge.

In nicer determinations, it is important to bring the liquid each time to a given volume, by adding water after the neutralization is nearly finished. For this purpose, two or more flasks of equal capacity are selected, and on the outside of each a strip of paper is gummed to indicate

the level of the proper amount of liquid, e. g. 200 c. c. The same amount of coloring matter being thus always diffused in the same volume of the same water, the errors of varying dilution and varying amount of ammonia (which is rarely absent from distilled water) are avoided. The contents of one flask, in which the neutralization has been satisfactorily effected, may be kept as a standard of color for the succeeding trials, as the tint remains constant for hours, being unaffected by the absorption of carbonic acid. The greatest convenience and accuracy of measurement are attained by using burettes provided with Erdmann's swimmer (*Jour. Prakt. Chem.*, lxxi, p. 194).

When three or four accordant results have been obtained, the average is taken as expressing the relative strength of the acid and alkali.

To ascertain the absolute standard, weigh off in a small platinum crucible about 0·8 grm. of pure carbonate of soda, ignite to dull redness, cool and weigh accurately: bring the crucible with its contents into one of the wide mouthed flasks and let flow from the burette a slight excess, e. g. 50 c. c., of standard acid. The solution of the carbonate of soda is facilitated by warming, and, finally, the contents of the flask are gently boiled for several minutes to expel carbonic acid. The solution is now allowed to become *perfectly cold*, then add ten drops of cochineal and lastly the standard alkali to neutralization, diluting to the proper volume.

To illustrate the accuracy of the process and the calculations employed, the following actual data may be useful. The normal acid was made by diluting 50 c. c. of oil-of-vitriol to the volume of ten liters and had half the strength above recommended. The alkali was from a stock on hand and more dilute than necessary.

Relation of acid to alkali.

Exp. I, 20 c. c. SO_3 = 32·8 c. c. KO, or 1 : 1·64
Exp. II, 20 c. c. SO_3 = 32·8 c. c. KO, or 1 : 1·64
Exp. III, 40 c. c. SO_3 = 65·7 c. c. KO, or 1 : 1·6425

We have accordingly:

1 c. c. SO_3 = 1·64 c. c. KO and 1 c. c. KO = 0·60976 c. c. SO_3.

Absolute strength of acid and alkali.

Exp. I. 0·4177 grm. of carbonate of soda were treated with 44·2 c. c. of SO_3. To neutralize the excess of the acid were required 3·8 c. c. KO, which correspond to 2·32 c. c. SO_3 (3·8 × 0·60976). Deducting this from the total amount of acid (44·2 − 2·32) we have 41·88 c. c. of acid, equivalent to the carbonate of soda taken.

41·88 c. c. solution of SO_3 = 0·4197 grm. NaO CO_2.

Exp. II. 0·4126 grm. NaO Co_2 treated with 44 c. c. SO_3 required 4·28 c. c. KO. 4·28 × 0·60976 = 2·61 c. c. SO_3. 44 − 2·61 = 41·39 c. c. SO_3.

41·39 c. c. solution of SO_3 = 0·4126 grms. NaO CO_2.

It is convenient to calculate how much acid corresponds to 53 decigrammes of carbonate of soda, since the relation of any other substance to the acid is then obtained by substituting its equivalent number for 53 (the equivalent of NaO CO_2), thus:

	grms. $NaO\,CO_2$		c. c. SO_3
I.	0·4177 : 0·53	::	41·88 : 53·14
II.	0·4126 : 0·53	::	41·39 : 53·17

Accordingly 0·53 grm. $NaO\,CO_2$ neutralize 53·155 c. c. SO_3.

If the solutions are employed for nitrogen estimations, we learn how much nitrogen corresponds to 1 c. c. of acid, by the following proportion.

c. c. SO_3		grm. N.
53·155 : 1·	::	0·140 : 0·0026338

We may then write on the label of the acid bottle the following data for calculation.

1 c. c. KO = 0·60976 c. c. SO_3.
1 c. c. SO_3 = 1·64 c. c. KO.
1 c. c. SO_3 = 0·0026338 grm. N.

As an example of the determination of nitrogen by help of these solutions, the following analysis of hippuric acid made by Mr. Peter Collier in this Laboratory, may be adduced.

0·3923 grms. hippuric acid were burned with soda-lime and the ammoniacal products were collected in 20 c. c. of the standard acid contained in the usually employed bulb tube. When the combustion was complete, the contents of the bulbs were rinsed out into a flask, brought to the volume of 150 c. c. and, after adding 10 drops of cochineal, the normal alkali was dropped in, until the change of color indicated neutralization; 13·7 c. c. of KO were required, = 8·354 c. c. SO_3 (13·7 × 0·60976) which deducted from 20 c. c. left 11·646 SO_3 as equivalent to the nitrogen of the hippuric acid. 11·646 × 0·0026338 = 0·0306732 N. ÷ 0·3923 = 7·818 per cent. The calculated per centage is 7·82.

The advantages of cochineal over litmus as an indicator, are as follows:

1. It possesses far greater sensibility. Luckow asserts that water which is tinged faintly orange by it, becomes distinctly red by the addition of $\frac{1}{200,000}$th of ammonia or $\frac{1}{1,430,000}$th of carbonate of lime.

When a little pulverized marble is covered with the diluted tincture and allowed to stand for some time, the lower stratum of liquid acquires a carmine tinge and by shaking, the whole solution becomes red. Luckow considers that in this case the carminic acid attacks the marble and forms a lime salt which causes the change of color. In this way the minutest traces of carbonates of alkali-earths may be detected in pulverized minerals, clays, &c. Alkali-salts must of course be removed by washing with distilled water free from ammonia.

This extreme delicacy allows of the use of much more dilute solutions than can be employed with litmus.

2. According to Luckow, cochineal is quite indifferent to carbonic and sulphydric acids, carminic acid being stronger than these. This is practically true for solutions of considerable strength. *Hence a normal alkali for technical analysis may be prepared by simply dissolving a weighed amount of carbonate of soda in a known volume of water*, and from this a standard acid may be easily made. In the neutralization it is not needful to expel carbonic acid by boiling. The influence of the latter is however at once seen when a caustic and carbonated alkali are operated with side

by side. In case of the former, the point of neutralization (or rather of supersaturation,) is shown by a prompt and decisive change from a tint in which orange predominates, to one in which this disappears and violet is most marked. In presence of carbonic acid the change is somewhat gradual, and though a red color is produced it is modified by an orange tint, even in presence of a large excess of alkali. Hence, it is to be recommended, especially in nice investigations, to employ a caustic alkali. A trifle less of it will be found needful to neutralize a given volume of acid, than is required of a carbonated solution, and no doubt will exist as to the point of saturation. Mr. Collier has made some experiments with a sulphuric acid containing 25 c. c. oil-of-vitriol to the liter and a solution of carbonate of soda and he found, when CO_2 was expelled by boiling, that 10 c. c. $SO_3 = 7{\cdot}66$ and $7{\cdot}67$ c. c. of $NaO\ CO_2$; when CO_2 was not expelled, 10 c. c. $SO_3 = 7{\cdot}68$ and $7{\cdot}7$. These results are as good as identical. In standarding the much weaker acid used for the nitrogen determination above mentioned, he obtained for it a value slightly too low when CO_2 was not removed. 0·53 grm. $NaO\ Co_2$ required in this case but 53·05 c. c. SO_3 instead of 53·155 as in the other instances. This is a very slight difference and not appreciable perhaps with ordinary burettes, but it is a constant and perceptible difference. What is of more importance is the uncertainty as to the point of neutralization.

This indifference towards carbonic acid is a great advantage in nice analyses, in that the time consumed for effecting neutralization is without influence on the result. When litmus is used and the point of neutralization is reached, a short exposure to the air suffices to redden the liquid again. If the operator is obliged to proceed slowly, he will require somewhat more alkali than when he operates rapidly; a portion of it being neutralized by atmospheric carbonic acid. With cochineal, the result is independent of the small amount of carbonic acid that can come from the air. The permanence of the color also allows several titritions to be compared directly together.

A third advantage of cochineal is, that its solution, prepared as above described, may be preserved indefinitely in closed vessels, without decolorization or alteration. S. W. J.

3. *On the solubility of Sulphate of Lime in chlorhydric acid.*—In this Laboratory it has long been the custom to bring into solution for analytical purposes gypsum, so-called super-phosphate of lime and other substances containing much sulphate of lime, by treatment with hot dilute chlorhydric acid. The action is rapid, and the analysis may be carried on with more convenience than when decomposition is effected by carbonate of soda. The sulphate of lime is not taken up by very concentrated chlorhydric acid to nearly the same extent as when the acid is dilute, and therefore a saturated solution of the salt in the latter is copiously precipitated by the addition of fuming chlorhydric acid as well as by that of water. S. W. J.

3. Technical Chemistry.

4. *Webster's process for producing Oxygen Gas.*—J. Webster of Birmingham (England), has taken out a patent for obtaining oxygen (and certain other products,) from nitrate of soda and oxyd of zinc, or peroxyd of iron, subjected to a low red heat in close retorts. The gaseous

products obtained are oxygen contaminated with variable quantities of nitrogen, and nitrous acid vapor, the latter of which is condensed by passing through water, while the residue in the retort consists of caustic soda and oxyd of zinc. Water completely separates these two, leaving the zinc-oxyd fit for a second operation. The soda solution serves for the manufacture of soap, while the mixed gases the process yields answer for the oxyhydrogen blowpipe and for various metallurgical purposes—or for increasing the brilliancy of coal gas, &c. Messrs. Pepper and Campbell have carefully examined and reported on Webster's process.[1] By the analysis of the former, the mixed gases consist of 59 vols. per cent of oxygen and 41 vols. per cent of nitrogen—while by Campbell's analysis the nitrogen was from 26·50 to 32·80 per cent of the whole. The process is conducted thus:—10 pounds of nitrate of soda (commercial) and 20 pounds of oxyd of zinc both previously dried, and warm, are roughly mixed and thrown into a red hot iron retort. The product, as soon as it will rekindle a taper, is conducted through a purifier—consisting of a 30 gallon stone-ware jar containing five pounds of water and eight moveable colander-like shelves, upon which are strown 48 pounds of residue, the product of previous operations, and consisting of zinc-oxyd, caustic soda and nitrate or nitrite of soda—this *caput mortum* stuff is moistened with five pounds of water and carefully strewn on the shelves (in the manner of the hydrate of lime, in the common, dry-lime purifier for coal gas). The purifier thus furnished is closed by a lid of stone-ware dropping into a 'water joint'—and is also connected with a capacious sheet iron gasholder. The product of gas from this charge was 33·69 to 32·968 cubic feet and the loss of weight in the process 5·5 pounds in the charge; the time occupied for the first charge was $2^h\ 5^m$, in second, $2^h\ 25^m$, the second charge being added without cooling the retort—the caput mortum by the structure of the retort being removed while it is hot, as in a continous operation. Campbell found the yield from 20 pounds of oxyd of zinc and 30 pounds of nitrate of soda, in two operations, to be 157·85 and 159·03 cubic feet, and the time in working each charge of 50 pounds, $9\frac{1}{2}$ hours. Campbell finds the proportion of nitrogen is diminished by using a moderate temperature and an increase of water in the purifier. This water becomes very acid from the NO_3 and NO_5 absorbed, these products resulting of course from the reaction of the materials.

The cost of oxygen by this process is less than from any other yet proposed as will appear from the following comparison, based on Deville's and Debray's well known statements.[2]

		frs.		*s.*	*d.*	English currency.	
1 cubic meter (= 35·317 cubic feet),		10	=	8	4	"	"
" "	from chlorate potassa,	4·87	=	4	$0\frac{3}{4}$	"	"
" "	Ox. manganese,	1·	=	0	10	"	"
" "	HO, SO_3 by heat,				$7\frac{1}{2}$	"	"
" "	Webster's $NaONO_5 + ZnO$,			1	$9\frac{7}{10}$	"	"
" "	Do. rejecting all products,						

It is plain from this statement that, without considering its purity, Webster's process is cheaper than any other: but Deville's method gives

[1] Chem. News, vi, pp. 218, 268, See also same Journal, vi, 287 and 289, vii, 34, for additional information.

[2] This Journal, [2], xxxi, 280, 427, and *Ann. de Chim. et Phy.*, [3], lxi, 97.

a pure gas. It is remarked however by Mr. Crookes[3] that the mixed gas of Webster's process is as pure as can be used in the arts unless in the metallurgy of the platinum metals. S.

5. *On the industrial applications of Cryolite.*—This interesting mineral, which a few years since was only looked upon as a mineralogical rarity, has now become an important article in commerce. Aside from its use as a source of aluminum as suggested by Percy and H. Rose, we learn from recent articles in *Dingler's Polytechnisches Journal*, that it is now extensively employed in chemical works at Copenhagen and Harburg for the production of caustic soda and salts of alumina.

J. Thomsen (*Ding. Jour.*, clxvi, 443) claims to have discovered in 1850 that cryolite could be decomposed by lime and lime salts, and after perfecting his process he commenced the manufacture of soda in 1857, and in 1858 erected large works at Copenhagen which now use 40,000 cwt. of cryolite annually. The exploration of the cryolite deposit in Greenland has become so extended that another large manufactory has been erected at Harburg, and others are being put up at Prague, Selicie and Mannheim. It is estimated that these manufactories will consume from 120,000 to 150,000 cwt. (6000 to 7500 tons) of cryolite annually.

The following method is used for converting the cryolite into soda ash and alumina salts: the cryolite is first ground to a fine powder and then mixed with chalk or ground limestone, in the proportion of 100 parts of cryolite ($3NaFl+Al_2Fl_3$) to 127 parts of carbonate of lime, equal to one equivalent of cryolite to six equivalents carbonate of lime. This when heated yields six equivalents of fluorid of calcium, aluminate of soda $2NaO+Al_2O_3$, and free carbonic acid. An excess of chalk in the mixture is found to be advantageous, as it renders the charge less fusible. The operation is conducted in a reverberatory furnace similar to those usually employed in alkali works. The compound of alumina and soda is dissolved in hot water and subsequently decomposed by carbonic acid, which last is obtained from the furnace in which the cryolite is decomposed. The carbonate of soda solution is separated from the precipitated alumina and either crystallized, or evaporated to dryness and calcined; it affords a remarkably pure soda ash, being, of course, free from chlorids and containing only traces of sulphites and sulphates, these last due to the small amount of sulphur contained in the coke. The greater portion of this soda solution is however converted into caustic soda by means of lime; the commercial article of caustic soda made at Harburg contains about 75 per cent of soda. The precipitated alumina, produced by the decomposition with carbonic acid, is washed with water and subsequently dissolved in sulphuric acid, yielding a sulphate of alumina entirely free from iron. (Schwarz, *Dingler's Journal*, clxvi, p. 283.) Cryolite is delivered at Harburg at two and a half Prussian thalers (about $2) a cwt. No mention is made of the economic application of the large amount of the fluorid of calcium produced in the above operation—aside from its use for making fluohydric acid, it unquestionably can be advantageously applied as a flux in many metallurgical operations. G. J. B.

[3] Chem. News, vi, 221.

4. PHOTOGRAPHY.—

6. *The action of light upon a sensitive plate.*—At a recent session of the Photographic Society of Marseilles, one of the members stated his having failed to obtain a good development in some *tannin* plates which had been kept some twenty days after exposure in the camera, although some of the same lot of plates had developed good results, when the development took place within twenty-four hours of the exposure.—Mr. Vidal explains this phenomenon by a new theory of the action of the actinic rays upon a sensitized plate. He supposes that under the action of light a certain molecular change, of a transitory nature, takes place, but that, in accordance with a general physical law, there is a tendency to return to the anterior molecular condition, and that in the process of time a plate exposed in the camera would, by returning to its original molecular condition, lose all trace of its exposure, and be ready to receive an entirely new impression, the same as a plate which had not been exposed at all. Mr. Vidal concludes that the physical theory of the *absorption* of the actinic fluid by certain substances, such as the iodid of silver, is the one which best explains photographic reactions.

We have only to say, briefly, in regard to this theory, that we have no faith in it whatever; it is contrary to our photographic experience; which confirms the theory that the action of light upon the sensitized plate is a *chemical* and not a *physical* action. The loss of sensitiveness, or the lack of ability to develope well after keeping—can be readily and satisfactorily explained by referring it to causes familiar to all practical photographers. E.

II. METALLURGY.

1. *On Aluminum Bronze.*—Lieut.-Colonel STRANGE has communicated to the Royal Astronomical Society some interesting observations on the use of aluminum-bronze as a material for the construction of astronomical and other philosophical instruments. Col. Strange remarks that, "the qualities of most importance in instrument making are, (1) tensile-strength; (2) resistance to compression; (3) malleability; (4) transverse strength or rigidity; (5) expansive ratio; (6) founding qualities; (7) behavior under files, cutting tools, &c.; (8) resistance to atmospheric influences; (9) fitness to receive graduation; (10) elasticity; (11) fitness for being made into tubes; (12) specific gravity."

Tensile strength.—The mean of experiments made by Mr. Anderson at the Royal Gun Factory, Woolwich, shows that the average breaking tensile strength of aluminum bronze is 73,185 lbs. per square inch, while that of gun-metal is 35,040 lbs., the ratio being rather more than two to one in favor of the aluminum-bronze.

Resistance to compression.—Experiments made by Mr. Anderson show that no effect was perceptible until 9 tons 2 cwt. per square inch was applied, when the specimen gave ·006 of an inch; on removing the weight an elasticity of ·001 was observed, giving the first permanent compression as ·005 of an inch. The ultimate amount of compression applied was 59 tons 2 cwt. 1 qr. 4 lbs. (132,416 lbs.), under which the specimen became too much distorted to permit of more weight being applied with any true result.

Malleability.—Mr. Anderson states that, "the qualities of this metal for forging-purposes would appear to be excellent; with the exception of the part heated to a red heat in the shade, all show that it is a good workable material under the hammer almost up to the melting point." Col. Strange adds, that there were specimens exhibited in the Industrial Exhibition at London which showed that the alloy could be drawn out under the hammer almost to a needle point.

Transverse strength, etc.—Messrs. Simms found by experiment that aluminum-bronze was 3 times more rigid than gun-metal, and upwards of 44 times more rigid than brass; and, in regard to its *expansive ratio*, they found this alloy less affected by change of temperature than either gun-metal or brass—a little less than gun-metal and much less than brass. Its *founding qualities* are such that it produces admirable castings of any size. It does not clog the file, and in the lathe and planing-machine the tool removes long elastic shavings, leaving a bright, smooth surface. It can be worked with much less difficulty than steel, and, notwithstanding its greater cost, the Messrs. Simms think that screws made of it would in the end prove less expensive than steel. It tarnishes less readily than any metal usually employed for astronomical instruments. It is remarkably well fitted to receive graduation, as it takes a fine division which is pure and equable, surpassing any other *cast* metal in this respect. Col. Strange remarks that in its elasticity it is said to surpass even steel, and it would therefore appear to be the most proper material for the suspension springs of clock pendulums. Regarding *its fitness for being made into tubes*, it can be soldered with either brass or silver solder; it can be rolled into sheet metal, and it can be hammered and drawn. Gun-metal does not admit of being rolled, so that hitherto the tubular portions of telescopes and other instruments have been made almost exclusively of yellow brass, an alloy very deficient in rigidity. The *specific gravity* of the alloy containing 90 copper and 10 aluminum is, according to Messrs. Bell, 7·689, very nearly that of wrought-iron.

Col. Strange adds, "it appears, from these experiments and from the concurrent testimony of those who have given it a fair trial, that the 10 per cent aluminum-bronze is far superior, not in one or some, but in every respect, to any metal hitherto used for the construction of philosophical apparatus, and that for such purposes it may be employed in the dimensions that would be proper in the case of cast steel. All parts which would otherwise be made of steel may with perfect safety, and even with advantage, be made of the new alloy, particularly such parts as bolts, and fixing, tangent, and micrometer screws. Its hardness and comparative inoxydizability point it out as peculiarly adapted for pivots, axes, and bearings. If employed for receiving the graduation of circles, the necessity for inlaying another metal will be obviated, by which two advantages will be gained: the hammering which forms part of the operation of inlaying, and which, more or less, must cause unequal density and tension in the circle subjected to such treatment, will be dispensed with; and the effect of inequality of expansion, in the circle and the inlaid strip, will no longer be a cause of apprehension. With respect to the due visibility of divisions cut on this metal, opinions will perhaps differ I can only say that I should be well content to observe with them."

This alloy has been selected by Col. Strange as the most appropriate metal for the construction of the large theodolite for the use of the Trigonometrical Survey of India. The horizontal circle of this theodolite is three feet in diameter, and the effect of using this alloy will be to keep the weight of the instrument within reasonable limits, notwithstanding its possession of means and appliances not hitherto bestowed on such instruments. In the manufacture of the alloy, Col. Strange says that extremely pure copper must be used; electrotype copper is best, and Lake Superior copper stands next, giving an alloy of excellent quality. The ordinary coppers of commerce generally fail, owing, it is said, to the presence of iron, which appears to be specially prejudicial. Further, the alloy must be melted two or three times, as that obtained from the first melting is excessively brittle. "Each successive melting, up to a certain point determined by the working, and particularly the forging properties of the metal, improves its tenacity and strength. It is probable that after several meltings there will remain in combination with the copper a somewhat smaller proportion of aluminum than 10 per cent. The present price of English-made 10 per cent aluminum-bronze is 6 shillings 6 pence per lb. This is four or five times that of gun-metal, but a much smaller quantity of the new alloy than of gun-metal will give the same strength; and when it is considered how small a ratio the cost of material bears to the cost of workmanship in refined apparatus, it will be found that even at the present price of the new alloy its cost is not prohibitory, whilst the advantages attending its use promise to outweigh the increased expenditure."—*L. E. and D. Phil. Mag.*, [2], xxiv, p. 508.

C. Tissier, Director of the Aluminum Works at Rouen, shows that one per cent of aluminum in copper makes the latter more fusible, giving it the property of filling the mould in casting, at the same time preventing it from rising in the mould. The action of chemical agents upon it is also weakened, and the copper gains in hardness and tenacity without losing its malleability, thus producing an alloy which has the malleability of brass, with the hardness of bronze.

In transverse strength, this alloy was found to be more than twice as rigid as either brass or copper. Tissier also finds that one part of aluminum, added to bronze consisting of 96 copper and 4 tin, gives an alloy of a fine color, of remarkable homogeneity, of great hardness and malleability. During casting, this alloy does not oxydize at all, and it is therefore free from the oxyd coating with which ordinary bronze castings are covered. The transverse strength of the castings of this alloy Tissier finds to be two and a half times that of the original bronze, and that of the hammered alloy is four times as great as that of bronze. Ordinary cannon-bronze, 89 parts copper and 11 tin, has the same transverse strength as castings of the new alloy. In reference to the hardness, tenacity and malleability, it is equal in these respects to aluminum-bronze, made of 90 parts copper and 10 parts aluminum, and, as it is considerably cheaper, it can with advantage be substituted for this more expensive alloy.—*Polytechnisches Journal*, clxvi, p. 430. G. J. B.

2. *Mineral and Metal products of Great Britain and Ireland.*—The following statistics are extracted from a paper on the Mines, Minerals and

Miners of the United Kingdom, read before the London Society of Arts by Mr. Robert Hunt, Keeper of the Mining Records.

Product for 1861.

Minerals.		Quantity.	Value.
Tin,	tons,	11,640	£ 725,560
Copper,	"	231,487	1,427,215
Lead,	"	90,696	1,136,249
Silver,	"	29	1,471
Zinc,	"	15,770	31,113
Pyrites,	"	125,135	79,715
Arsenic,	"	1,450	10,875
Nickel,	cwt.,	16	24
Wolfram,	tons,	8	29
Antimony,	"	15	45
Manganese,	"	925	2,925
Gossan, ochre, &c.,	"	3,016	3,016
Iron ore,	"	7,215,518	2,302,371
Coals (sold and used),	"	83,635,214	20,908,803
Other minerals,	"	2,222,602	880,114
Total value of Minerals produced in 1861,			£27,509,525

Metals produced from British Minerals.

		Quantity.	Value.
Gold,	oz.,	2,784	£ 10,816
Silver,	"	569,530	144,161
Tin,	tons,	7,450	910,762
Copper,	"	15,331	1,572,480
Lead,	"	65,643	1,445,255
Zinc,	"	4,415	79,101
Iron, Pig,	"	3,712,390	9,280,975
Total value,			£13,443,550
Estimated value of other metals,			250,500
Coals,			20,908,803
Total value of metals and coals,			34,602,853

There were worked, in 1861, 3052 collieries, 167 copper mines, 148 tin mines, 390 lead mines and 29 zinc mines—number of iron mines not given. The whole employed an aggregate of 336,000 persons actually engaged in mining operations, exclusive of quarries of all kinds. —*Journal of the Society of Arts*, xi, 94. G. J. B.

3. *The Mining and Smelting Magazine, a monthly review of Practical Mining, Quarrying and Metallurgy, and record of the Mining and Metal Markets;* edited by Henry Curwen Salmon, F.G.S., F.C.S. Vol. I and II. London, 1862.[1]—Besides the objects mentioned in the title, this monthly contains original articles of great value on mining and

[1] Published monthly, at one shilling sterling per number. Agents, Baillière Brothers, 440 Broadway, New York.

metallurgical subjects. Among its contributors are Warrington W. Smyth, Robert Hunt, H. W. Bristow, James Napier, J. A. Phillips, Professor Ansted, and others who are well known to both scientific and practical men. It also contains translations of valuable memoirs from the *Annales des Mines* and other foreign journals. It is well illustrated with maps and plans of mines, furnaces, etc. We trust that this magazine will meet with the success it deserves, as it fills a want that has long been felt by miners and metallurgists.

III. PHYSIOLOGICAL AND AGRICULTURAL CHEMISTRY.

1. *On the Chemistry of Germination.*—Dr. Max Schulz has published (*Jour. für Prakt. Chem.*, lxxxvii, p. 129) an extended investigation on this subject. He directs attention to the insufficiency of elementary analysis, as employed by earlier experimenters, for determining the chemical changes that occur in germination, and substitutes for it Bunsen's gasometric methods. Various seeds, viz: those of *Lepidium sativum*, *Lupinus albus*, *Vicia faba*, and *Iberis amara*, were made to germinate in pure water contained in sealed glass flasks. The chemical changes that took place were studied by analyzing the air of the flasks after a suitable interval. Schulz arrives at the following results, which he deems fully established in regard to what he terms the *first stage* of germination, or that period in which no cell-multiplication is observable, but during which the embryo merely bursts the integuments and extends itself with the radicle in a downward direction.

1. The first stage of germination is set up or made possible by the decomposition of albuminoid substances. 2. This decomposition is produced by the absorption of water and oxygen. 3. In its progress, *nitrogen* and carbonic acid and afterward *hydrogen* are set free. By several experiments made with crushed seeds, Schulz found that, in decay or putrefaction, nitrogen and carbonic acid were evolved, though less rapidly than in germination; but that *free hydrogen did not appear.*[1] Schulz hence concludes that the evolution of hydrogen, in his experiments, truly belonged to the germinative process, and was not a result of accompanying decay. From the circumstance that seeds will not develope in sealed vessels of suitable dimensions, beyond, or but little beyond, the first stage, owing to the accumulation of carbonic acid, Schulz was not able to investigate fully what happens in the later periods of germination. In the few trials that partially succeeded, he obtained the same results as were manifested in the first stage, though the liberation of free hydrogen appeared to be less copious, relatively to that of the nitrogen and carbonic acid.

S. W. J.

[1] Dr. Pugh, President of the Ag. College of Penn., obtained *a large amount of free hydrogen and but traces of nitrogen* from decomposing vegetable matters (wheat, barley, beans and turnips) when they were placed in water over mercury, *atmospheric air being removed* by communicating the vessel containing them with the Torricellian vacuum. (*Lawes, Gilbert and Pugh on the Sources of the Nitrogen of Vegetation, Phil. Trans.* part II, 1861.)

It would thus appear to be experimentally established, that in the chemical process of decay, hydrogen is evolved only in the absence, and nitrogen only in the presence of an excess of free oxygen, whereas in the vital process of germination, hydrogen and nitrogen are both eliminated in presence of oxygen. Further, in the

2. *On the reduction of kinic acid to benzoic acid, and its conversion into hippuric acid in the animal organism.*—According to LAUTEMANN (*Ann. Ch. u. Pharm.*, CXXV, p. 9), when kinic acid is heated with a saturated aqueous solution of iodhydric acid in a sealed tube for two to three hours, at 115 to 120° C, benzoic acid and iodine are obtained. The same conversion is effected by bringing into a retort two equivalents of iodine with one equivalent of phosphorus, and, after the two have united and the product is cold, adding to four equivalents of the crude iodid of phosphorus one equivalent of kinic acid dissolved in water to a syrupy solution. On warming gently, a vigorous reaction sets in, iodhydric acid escapes and water distils over. When the iodid of phosphorus has mostly disappeared, the contents of the retort on cooling solidify to a fat-like crystalline mass, from which ether extracts impure benzoic acid. The retort neck is also lined with crystals of this acid toward the close of the process.

$$\overset{\text{Kinic acid.}}{C_{14}H_{12}O_{12}} = \overset{\text{Benzoic acid.}}{C_{14}H_6O_4} + 6HO + 2O$$

The reaction may proceed according to either of the following equations.

1. $C_{14}H_{12}O_{12} + 8HI = C_{14}H_6O_4 + 8HO + 8I$
2. $C_{14}H_{12}O_{12} + 8I = C_{14}H_6O_4 + 6HI + 2I$

Since kinic acid is thus converted so easily into benzoic acid, it occurred to Lautemann to examine whether it would undergo the same change in the animal organism, and appear in the urine as hippuric acid. He found this to be actually the case, in trials upon himself and two other persons, 8 grms. of kinate of lime yielding in two experiments 2·2 and 2·7 grms. of hippuric acid, respectively. Kinic acid having been proved by Zwenger and Sievert to exist in considerable quantity in the whortleberry plant, it becomes probable that it may also occur in various grasses, and that it is the origin of the hippuric acid which is found in the urine of pastured animals. S. W. J.

3. *On the composition of the urine of oxen as related to their fodder.*—HENNEBERG, STOHMANN and RAUTENBERG, (*Ann. Ch. u. Pharm.*, CXXIV, p. 200,) at the conclusion of an important paper chiefly occupied with an account of the method they employ for the determination of hippuric acid, urea and chlorid of sodium in urine, give the following *resumé* of results obtained with the urine of three oxen during seven months of 1860–61.

1. The urine had the maximum content of hippuric acid—2·1 to 2·7 per cent—when the cattle fed chiefly on *oat and wheat straw* with a small addition of crushed beans. When *leguminous forage* (clover hay and bean straw) was exclusively supplied, the hippuric acid fell to 0·4 per cent and less. With *meadow hay* the percentage was intermediate, viz: 1·2 to 1·4 per cent.

2. The addition of considerable quantities of easily digestible food, *e. g.* bean-meal, starch, sugar and oil, to the proper fodder, had the effect to diminish the amount of hippuric acid, and increase that of urea.

vital process of "vegetable respiration" if not free hydrogen yet carburetted hydrogen and carbonic oxyd, but no free nitrogen, are given off in conjunction with oxygen, Boussingault (*this Journal*, XXXV, p. 122); while, as Pettenkofer and Voit have shown, (*Ann. Chem. u. Pharm.*, ii, Sup. vol. 66), both carburetted hydrogen and free hydrogen are found in the products of animal respiration. S. W. J.

3. The quantity of bicarbonates in the urine depends upon the amount of carbonates or salts of vegetable acids present in the food. The several materials used as rations in these experiments gave, by *incineration in the muffle*, ashes having the following quantities of carbonic acid to 100 of dry substance.

Clover-hay,	2·4	pts.	CO_2
Bean-straw,	1·6	"	"
Meadow-hay,	1·1	"	"
Oat-straw,	0·2	"	"
Wheat-straw,	0·0	"	"
Crushed beans,	0·0	"	"

In the urine, the greatest amount of carbonic acid—1·6 to 1·8 per cent—was observed after feeding with clover-hay. In urine excreted after the ingestion of wheat-straw and crushed beans, carbonic acid was totally wanting. The urine from cattle fed on wheat-straw had an acid reaction notwithstanding it was destitute of carbonic acid, while in every other instance the reaction was alkaline. By adding to the day's ration of straw 75 grms. acetate of potash, the carbonic acid and the alkaline reaction reappeared. S. W. J.

4. *On some points in the composition of Soils.*—It has been assumed by chemists that hydrated oxyd of iron and hydrated alumina as well as hydrated silica are usual ingredients of soils, though no direct proof of their presence has been furnished. Alexander Müller (*Die landwirthschaftlichen Versuchs-Stationen*, iv, p. 227) has examined various soils for these substances by treating them with solution of a neutral or ammoniacal tartrate and with carbonate of soda. Müller finds that seignette salt when boiled with hydrated sesquioxyd of iron dissolves the latter, forming a dark-brown alkaline solution. The hydrated sesquioxyd does not lose its solubility by air-drying nor by drying at 212°, though, in the latter case, it dissolves with more difficulty. Hydrated alumina behaves similarly, but appears to go into solution with less rapidity. Silicates of these oxyds are insoluble in the ammoniacal solution of tartrates which easily take up the hydrates.

The only soils which yield to this reagent noticeable quantities of hydrated oxyd of iron (and hydrated manganeso-manganic oxyd) are those which possess a perceptible ocher-yellow color. Red soils, and also those having a light color, yield little iron to a tartrate, compared to that which is removed from them by hydrochloric acid. The yellow soils thus contain hydrated sesquioxyd, the red, anhydrous sesquioxyd, and the light-colored soils appear to contain a silicate of iron.

Hydrated alumina Müller scarcely found at all. He supposes that alumina exists in nearly all cases as a silicate.

By digesting the clayey soils of the vicinity of Stockholm directly with solution of carbonate of soda, or by treatment with chlorohydric acid, but very little silica is taken up. On the other hand, the residue that remains after acting on them with chlorohydric acid yields much silica; in some cases, even 15 per cent. It hence appears that in the soil the silica exists for the most part in a state of combination.

Note.—There can be little doubt that the hydrous silicates of the various bases occurring in the soil—or its zeolitic constituents as they

may be termed, enact a series of most important functions. The researches of Daubrée on Metamorphism, *Ann. des Mines*, [5], xvi, also *Smithsonian Report*, 1861, have elucidated, in the most clear and striking manner, the conditions and results of the action of warm water on the anhydrous silicates, and have shown that crystallized zeolites may be produced from them by its influence. Way and Eichhorn (*this Jour.*, xxvii, 71–85) have made it in the highest degree probable, that the absorbent power of soils for the alkalies is due to the action of amorphous zeolitic compounds; and it is hardly to be questioned, that the good (or bad) results of tillage and many of the hitherto inexplicable effects of manures, will be found to bear close relations to the processes of soil-metamorphism, in which silicates, water and carbonic acid play the chief parts. S. W. J.

IV. MINERALOGY AND GEOLOGY.

1. *Manuel de Minéralogie* par A. DesCloizeaux, Maitre de conférence à l'Ecole Normale supérieure, etc. Tome premier, 572 pp., 8vo. Paris, 1862.—This Manual of Mineralogy embodies the results of a very large amount of original research by the author. DesCloizeaux has for many years been engaged in studying the optical and crystallographic characters of mineral species, and by these means, especially the former, has thrown new light on doubtful species, distinguished many that have been confounded together, and referred others, supposed to be distinct, to their true places. Many of these results have already been mentioned briefly in former numbers of this Journal,[1] and it is hardly necessary to enter into details in this place. Suffice it to say that the work is a source of original information on minerals, indispensable to all who are interested in having an accurate knowledge of species.

2. *Report on the Geological and Mineralogical specimens collected by* Mr. C. F. Hall *in Frobisher Bay.*[2]

To the New York Lyceum of Natural History:—

One of your committee, appointed to examine the collection of minerals and fossils made by Mr. Chas. F. Hall in his late Arctic Exploring Expedition, begs leave to report, that he found the collection of fossils small in number of individual specimens, and limited in the range of its species, but possessing great interest to the student of Arctic geology.

The specimens are as follows:—

Maclurea magna (Lesueur).	No. of specimens		7
Casts of lower surface.	"	"	3
Endoceras proteiforme? (Hall).	"	"	1
Orthoceras (badly worn specimens).	"	"	3
Heliolites (new species).	"	"	2
Heliopora " "	"	"	1
Halysites catenulata (Fischer).	"	"	1
Receptaculites (new species).	"	"	1

This collection was made at the head of Frobisher Bay, lat. 63° 45′ N.,

[1] [2], xx. 270, xxv, 396, xxix, 363, xxxi, 356, xxxiv, 203.

[2] Communicated to this Journal by the Lyceum.

and long. 70° W. from Greenwich, at a point which, Mr. Hall says, is 'a mountain of fossils,' similar to the limestone bluff at Cincinnati, with which he is familiar. This limestone rests upon mica schist, specimens of which he also brought from the same locality. Whether the limestone was conformable to the schist or not, Mr. Hall did not determine. It is much to be regretted that this interesting point was not examined by him, as it is doubtful whether this locality may ever be visited by any future explorer.

The fossils, without doubt, are all Lower Silurian. The *Maclurea magna* would place the limestone containing it on the horizon of the Chazy limestone of New York. The *Halysites catenulata* has been found in Canada in the Trenton beds, but in New York not lower than the Niagara Limestone. The *Endoceras proteiforme* belongs to the Trenton limestone. The *Receptaculites* is unlike the several species of the Galena limestone of the West, or the *R. occidentalis* of Canada. Mr. Salter speaks of one found in the northern part of the American continent. This may be that species, or it may be a new one; which it was, we have no means of determining. The *Orthocerata* were but fragments, and so badly water-worn that the species could not be identified.

The specimens of corals were very perfect and beautiful, and unlike any figured by Prof. Hall in the Palæontology of New York. The *Heliolites* and *Heliopora* belong to the Niagara group, in New York, but in Canada they have been found in the Lower Silurian. For the identification of strata, corals are not always reliable. Whether these species are similar or identical with any in the Canadian collection, it was out of my power to determine. They are unlike any figured by Mr. I. W. Salter. R. P. Stevens.

One of the committee, appointed to examine the mineral specimens brought from Frobisher Bay by Mr. Hall, reports that the specimens though quite numerous were mostly of the same general character. The rocks were nearly all mica schist; some of the specimens were taken from boulders, some from the ruins of houses, and had the mortar still attached, and some were from the rock in its natural position. There was nothing peculiar in the rock, it presenting the usual variations in composition. The other specimens were an argillaceous limestone determined by its fossils to be Lower Silurian; a single specimen of quartz, crystallized and presenting besides the usual six-sided termination another pyramid whose angle was much more obtuse; magnetic iron, some of which was found *in situ* and other specimens which were evidently boulders and had undergone for some time the action of salt water; a few pieces of iron pyrites, bituminous coal and nodules of flint or jasper. * * * *

[The part of this Report omitted gives reasons for believing the coal and siliceous nodules to have been brought from England by Frobisher, who, it is well known, took out large supplies and many miners, expecting to mine and smelt ores; some "blooms" of iron which Mr. Hall found may have been the result of their operations with the magnetic iron.—Eds.]

* * * This theory is supported by the traditions of the natives, who say that the coal was brought there by foreigners,[1] as well as by the

[1] Everything that seems to them peculiar they refer to this source.

entire absence of any indications of geological strata so high up in the series as the Carboniferous formation. The siliceous pebbles seem to have served as gravel for the mortar used in building the houses for carrying on the various objects for which the expedition was sent out. No trace of any mineral containing silver existed in the collections. The sands supposed by Mr. Hall to be those in which Frobisher found gold have not yet been assayed. A small bead detached from an ornament worn by the natives was found to be lead. THOS. EGLESTON.

But little attention was paid to zoology, Mr. Hall not having the means at hand for the preservation of specimens. A single specimen of a mollusk, in a dried state, was sent to Wm. Stimpson, Esq., for examination. He writes as follows: "I find the specimen to be *Cynthia pyriformis* Rathke, an Ascidian mollusk, originally found on the coast of Norway." Only two species of birds were brought, viz: *Colymbus torquatus* Brunwich, and *Plectrophanes nivalis* Linn.

Of mammals, he obtained two Lemmings which were referred for determination to Prof. S. F. Baird of the Smithsonian Institution. He informs me that they agree best with *Georychus helvolus* Audubon, and he should so consider them for the present. GEO. N. LAWRENCE.

3. *Note on a fossil Echinoderm from the Blue Limestone (Lower Silurian) of Cincinnati, Ohio;* by J. D. DANA.—In vol. i, (1846) page 44 of the second series of this Journal, there is a paper on a fossil Echinoderm from the Blue Limestone of Cincinnati, by G. GRAHAM, J. G. ANTHONY and U. P. JAMES, illustrated by a figure from a drawing by the last-mentioned. In a recent letter from Mr. James, the writer learns that the specimen was discovered by him in March, 1846, and that it still remains in his possession and is the only one yet found. The species is referred in the article to the genus *Asterias*. In the writer's Manual of Geology, the figure is reproduced on page 221, and the provisional name annexed of *Asterias Anthonii*. From an examination of the drawing, Mr. E. Billings of Montreal, well versed in Silurian Echinoderms, concludes that it comes nearest to the genus *Palasterina* and may belong to it. Deriving the name from the true discoverer, the species will then be the *Palasterina (?) Jamesii*.

4. *On a new Crustacean from the Potsdam Sandstone;* by Prof. JAMES HALL, (*Canadian Naturalist and Geologist*, Dec. 1862, vii, p. 443.)—The Crustacean fossils here described and figured are the cephalic shields of a species supposed by Prof. Hall to approach in character the modern Limulus. They are from the Potsdam sandstone of Wisconsin. The shield is three times as broad as long, has a strong thickened border, rounded lateral angles, and small but quite prominent eyes. Other fragments have been obtained in the region of the Upper Mississippi, and one is a straight spine, which may have been, Prof. Hall observes, the caudal spine of this species. It is suggested that the tracks, called *Protichnites*, found in the Potsdam sandstone of Canada by Logan, may have been made by this species; and this is urged as the more probable, since, in 1857, similar tracks were observed by E. Daniels, of the Geological Survey of Wisconsin, in the Potsdam sandstone of Black River.

5. *Proceedings of the Portland Society of Natural History*, vol. i, part 1.—This volume of 100 octavo pages is the first publication, in

form, of the Portland Society of Natural History. It contains many papers of interest, a plate of coal plants of the Carboniferous age, and a valuable geological map of the northern portions of the state of Maine. If the future numbers of the Proceedings are equal to the first, their publications will contribute much to the progress of science.

Most of the papers in Part 1 appear to have been communicated by members of the Scientific Survey of Maine: and we understand that the first set of specimens collected by the authority of the state government will be deposited in the rooms of the society. The following are the titles of the most important papers in Part 1. A catalogue of the Flowering Plants of Maine, by G. L. Goodale, Botanist to the Maine Scientific Survey :—Catalogue of the Mammals and Birds of Maine, compiled by C. H. Hitchcock, State Geologist :—Notes upon the Geology of Maine, by C. H. Hitchcock :—Catalogue of the Reptiles and Amphibians of Maine, by B. F. Fogg, M.D. :—Fossils of the Potsdam Group of North America, by C. H. Hitchcock :—Grooved Boulders in Bethel, Maine, by N. T. True, M.D. :—Description of a new species of Carpolithes from the Miocene Tertiary of Vermont, by C. H. Hitchcock.

6. *On the present condition of the Crater of Kilauea on the island of Hawaii*; by Rev. TITUS COAN.—The following facts on the present condition of the crater of Kilauea are taken from a letter addressed to Prof. C. S. Lyman by Rev. T. Coan, dated Hilo, Hawaii, Nov.13, 1862.

"Very great changes have taken place in Kilauea since your visit in 1846.[1] The great dome, some two miles in circuit, which was raised over Haluemauma [the lake of lava situated in the south extremity of the crater of Kilauea,] has subsided, leaving a corresponding depression or crater. It is as if a great cauldron had been turned right side up and set for boiling. Near the center of this depression, there is an active lake about 600 feet in diameter. Sometimes this lake is sluggish, and again it boils and rages, tossing its fiery masses and throwing up its jets of melted lavas 20 to 50 feet high. Occasionally it overflows, or rends its rocky sides, and sends off streams to harden in other parts of the crater. Within the aforesaid basin or crater, and one-fourth of a mile from the active lake, a great mound has been recently raised, and on its summit a huge mass of lava is piled up, rising into pinnacles and turrets, of such form as to resemble, in the distance, a cathedral. This is called Pelé's Temple.

All the central portion of the crater of Kilauea has been elevated by upheaving forces, and the circuit, once the "Black Ledge," has been raised by superincumbent deposits or overflowings proceeding from the southern portion of the crater. I think the central area is not more than 600 feet below the highest point in the outer wall of Kilauea. Near this central portion of the crater rests an irregular and broken ridge of immense masses of very compact basalt filled with grains of olivine or chrysolite."

7. *Arsenids of Copper from Lake Superior.*—SCHEERER gives in the *Berg- und Hüttenmännisches Zeitung*, xx, p. 152, an account of a specimen of a metallic mineral found as a boulder on the banks of the St. Louis River, near Superior City, Wisconsin. He found it to contain 86 pr. ct. of copper and 14 pr. ct. arsenic. On the weathered surfaces it was black, while on the fresh fracture it was yellow, tarnishing and becoming black on exposure to the air. It was considered by several members of the

[1] See this Journal, [2], xxii, 75.

"Miners' Union" at Freiberg to be a furnace product, perhaps made by the Indians. Dr. Kenngott very properly classes this substance with whitneyite (*Uebersicht*, 1861, p. 114), and the mass is unquestionably a mixture of whitneyite and algodonite similar to that described by Dr. Genth (*this Journal*, [2], xxxiii, p. 191). A further notice of this boulder has been sent to Prof. Silliman, Jr., by Col. Chas. Whittlesey of Cleaveland, from which we extract the following facts. It was found on the bank of the St. Louis river at Rice's Point, one and a half miles from the west end of Lake Superior. It was about one foot in length, and weighed from 95 to 100 lbs.; on the fracture it was crystalline and contained small pieces of calc-spar. The fragment analyzed by Scheerer was sent to him by Col. Whittlesey through Mr. Boole, who was then a student in Freiberg. Col. Whittlesey considers that this boulder was transported to the St. Louis River, from some vein, by the northern drift. It had the usual worn aspect of the copper boulders of the Lake Superior region.

The writer is informed by Mr. C. F. Eschweiler, Superintendent of the Isle Royale Mine, that a *vein* of arsenids has recently been discovered on the property of the Columbia Mining Company at Houghton. The whitneyite is there found associated with native copper and domeykite.

G. J. B.

8. *Catalog einer Sammlung vom 675 Modellen in Ahornholz, zur Erläuterung der Krystallformen der Mineralien, ausgegeben vom Rheinischen Mineralien-Comptoir des* Dr. A. KRANTZ in Bonn. pp. 50, 8vo. Bonn, 1862.—This catalogue is a description of the collection of crystal models now made by Dr. Krantz. The models 1 to 78 illustrate the monometric system, 79 to 151 the dimetric system, 152 to 343 the hexagonal system, 344 to 506 the trimetric system, 507 to 645 the monoclinic system, and 646 to 675 the triclinic system. Among these are 81 models of twin crystals, illustrating twinning in 44 species. The whole represent 222 mineral species. The catalogue contains under each number the name of the form or species, the crystallographic symbols of the planes, according to both Naumann and Miller's notations, and references to the figure corresponding to the model in Naumann, Miller, Rose, Dana, Dufrénoy and other prominent treatises of Mineralogy. The models are made with the greatest accuracy; many of them are copies from models furnished to Dr. Krantz by G. Rose and Hessenberg. They are made of maple, and have an average diameter of 5 centimetres (about 2 inches). They are sold in Bonn for 120 Prussian thalers.

G. J. B.

V. ZOOLOGY.

1. *Contributions to Conchology*, vol. ii.—*A Monograph of the Order Pholadacea and other papers;* by GEORGE W. TRYON, Jr. Dec. 31, 1862. —This volume of 127 pages is composed of articles printed originally in this Journal, and in the Proceedings of the Academy of Natural Sciences of Philadelphia. The first volume, containing a bibliography of American Conchology, was published independently in 1861. The seven articles in the present volume are, "*On the Mollusca of Harper's Ferry, Virginia*," (pp. 9–11), "*A sketch of the history of Conchology in the United States*," (13–32),[1] "*Synopsis of the Recent Species of Gastro-*

[1] See this Journal, [2], vol. xxiii, March, 1862.

chænidæ, a Family of Acephalous Mollusca," (33–62), "*On the Classification and Synonymy of the recent species of Pholadidæ*," (63–93), "*Notes on American fresh water Shells*," (95–96), "*Monograph of the family Teredonidæ*," (97–126), and "*Description of a new Genus and Species of Pholadidæ*," (126–127).

The *Pholadacea*, as will be seen from the above list, are divided into three families, first severally distinguished by Mr. Carpenter. These families may be natural, the *Teredonidæ* being most justly separated from the *Pholadidæ*, with which they had been confounded until distinguished by Carpenter; but, to the number admitted by Mr. Tryon, would perhaps be properly added another, the *Aspergillidæ* of Gray; the presence of fringes or tentacles at the front of the mantle, and the consequent development of tubuli radiating from the edge of the anterior disk of the tube, conjoined with the modification of the other part, appear fully to justify that distinction. There would then be four allied families, *Pholadidæ*, *Teredonidæ*, *Gastrochænidæ* and *Aspergillidæ* or *Brechitidæ*. The propriety of the erection of this group of families into an "order," as has been proposed by some and adopted by Tryon, is extremely questionable.

The genera of the *Pholadacea* accepted by Mr. Tryon are numerous, but apparently not more so than are natural. A number, it is true, have been refused by many conchologists, chiefly on account of the burthen on the memory caused by the multiplication of generic names; but, as it is not quite evident what relation the powers of memory have to the existence of natural groups, scientific men will doubtless prefer to express in a scientific nomenclature the structural modifications that nature indicates.

The "description of a new genus and species of *Pholadidæ*" forms an Appendix to the monograph, and makes known an interesting addition to our Fauna, the *Diplothyra Smithii* of Tryon, from New York Bay; the genus indicated belongs to the subfamily *Jouannetiinæ* of Tryon, distinguished by the development of a callous plate closing the anterior ventral gap of the adult shell, and also, it might have been added, by the perfect union of the siphonal and anal tubes, and the fringed border of the common tube in the known animals. The bibliography of the monograph is exhaustive, almost every reference to any genus or species having been given. The author proposes to publish an illustrated descriptive monograph of the same *Pholadacea* at a future time, if furnished with requisite material—for which he appeals to collectors.

In the "Notes on American fresh water Shells," the subdivision of the genus *Vivipara* Montfort (properly *Viviparus*), into four subgenera, *Vivipara*, *Tulotoma* Hald., *Melantho* Bowd, and *Haldemania* Tryon, is proposed. This view will doubtless be accepted, although the distinguishing characters of *Melantho* are not given. The latter includes the ordinary *Paludinæ* of the Eastern States, and is distinguished by the form of the shell, the sigmoidally sinuous outer lip, &c. A family *Amnicolidæ* is also proposed for the reception of *Amnicola*, but is unaccompanied by a diagnosis. The distinction of that genus from the *Viviparidæ* as well as *Littorinidæ* and *Rissoidæ*, is justifiable; it is indeed more nearly related to the Melanians but has no lateral jaws. The characters

of the family, as well as of the *Viviparidæ*, and the subdivisions of each, will be given in another place by the reviewer. The genus *Amnicola* is proposed to admit the new subgenus *Pomatiopsis*, based on *A. lapidaria* and other elongated species. The correctness of this distinction at least remains to be verified on the animal.[2] Two more distinct types exist in the *A. Cincinattensis* G. & H., and the globular *A. depressa* Tryon. The former, on account of its reflected circular lip, has been named by the reviewer *Chilocyclus*, while the latter, distinguished by its large, globose body-whorl, is called *Somatogyrus*.

The memoirs, brought together in this volume, are valuable contributions to science, and will doubtless obtain for the author the merited thanks of the scientific world. It were to be wished that more conchologists would imitate him in precision and knowledge of bibliography. T. Gill.

2. *Analytical Synopsis of the order of Squali, and Revision of the Nomenclature of the Genera;* by Theodore Gill. pp. 42(–47). (Reprinted from *Annals of New York Lyceum*, vol. viii.) *On the Classification of the Families and Genera of the Squali of California;* by Theodore Gill. (*Proc. Acad. Nat. Sci. Phila.*, Oct., 1862).—The two articles cited are devoted to the systematic revision of the families and genera of Sharks, which the author regards as constituting an order of Elasmobranchiate Fishes, distinct from the Rays; the ordinal name of *Squali*, previously used in a subordinal sense, has been retained. The "analytical synopsis" is divided into three chapters,—1st, "*On the history of the order*," in which a review of the principal classifications of the sharks is given, and their respective merits discussed; 2d, "*On the relations of the order*," in which the isolation of the *Rhinæ* (*Squatinæ* Dum.) as a distinct suborder, is urged, and the nearer affinity of that group to the order of Rays is contended for; the relation of the families sought to be ascertained, and the most striking peculiarities of the geographical distribution of the several types pointed out; and 3d, "*Systematic Arrangement*." In this portion of the synopsis, two analytical tables are first given, illustrating the principal or most apparent distinctions of the different families, sixteen of which are admitted; these are followed by similar analytical tables for the respective families, the dichotomous method being applied to facilitate the identification of the various genera. After the "synopsis" of each family, an enumeration of the subfamilies and genera is presented, in which the authorities, typical species, and synonyms of the generic names are given. As a sequel to the whole, the latin diagnoses of fifteen new genera are offered; this, added to the number adopted from others, gives a total of fifty-eight represented in our present seas; to that number, six others are superadded in the supplementary article on the Californian sharks.

The classification adopted in the synopsis is said to be a "modification of that of Müller and Henle. The principal differences consist in the arrangement of the *Scyllioids* at another point in the series, and their distribution among three families, and in the union of the Müllerian families of the *Carchariæ*, *Triænodontes*, *Galei*, *Scylliodontes* and *Mus-*

[2] The *A. lapidaria* itself perhaps belongs to the *Aciculidæ*, and consequently to a different family from the other species.

teli in one, but after the exclusion, from the first, of the hammer-headed sharks, which appear to constitute a distinct family, *Cestraciontoidæ*, (the *Zygænæ* of former American authors and not the *Cestraciontes* of Agassiz) recognized as such by most of the recent systematists." The terminology of the family names is also different from that adopted by the German naturalists, the terminal syllables *oidæ* being employed; and the subdivision into subfamilies is likewise original. The principal changes in the nomenclature result from the revival of names proposed by Klein and Rafinesque. A still further modification is proposed in the article on Californian sharks, where the proposition is made to distinguish the genus *Oxynotus* of the synopsis (*Centrina* Cuv.) as the type of a special family, and the arrangement of the genera left in the *Spinacoidæ* is considerably altered. In the same article, the family of *Heterodontoids* of the author (*Cestraciontes* Ag.) is made to include three genera, the Californian species (*Cest. Francisci* Grd.) being fully described as the type of one (*Gyropleurodus*), and a species illustrated in the *Zoology of the Venus* being proposed as that of another named *Tropidodus*. The author is inclined to exclude many of the genera referred by Prof. Agassiz to the Cestraciontes, from that family, and has restricted it with reference chiefly to the living forms. One of the chief characters noticed, as distinguishing the family from all other existing types, is the form of the head, and the rapid declension of profile from the interorbital region.

In accordance with the classification proposed in the Synopsis, there are eight families of *Squali* represented along the eastern coast of the United States;—(Squali) *Lamnoidæ*, *Odontaspidoidæ*, *Alopecoidæ*, *Cestraciontoidæ* (*Zygænæ*), *Galeorhinoidæ* (*Carchariæ*), *Spinacoidæ*, *Scymnoidæ*, and (Rhinæ) *Rhinoidæ*, (*Squatinæ*). Along the western coast, only five are yet known to be represented; the *Galeorhinoidæ*, *Heterodontoidæ*, *Notidanoidæ*, *Spinacoidæ*, and *Rhinoidæ*. A.

3. *On the mode of development of the marginal tentacles of the free Medusæ of some Hydroids;* by A. Agassiz. 14 pp., 8vo. (From the *Proc. Bost. Soc. Nat. Hist.*, vol. ix, August.) *On Alternate Generation in Annelids, and the Embryology of Autolytus cornutus;* by A. Agassiz. 26 pp., 8vo, with 3 plates. (From the *Journ. Bost. Soc. N. H.*, vii, 392, 1862.)—These papers by A. Agassiz (son of Professor Agassiz) contain the results of careful research, bearing on facts of great zoological interest. The first relates to the order of succession in the development of the marginal tentacles of Medusæ. Designating each new intermediate series by t and a number, added as an index expressing the order in time of the several series, he makes out a formula for the order of arrangement, and also for the number of tentacles. Thus, in a young *Tiaropsis*, the formula for the number of tentacles is

$$\Sigma t = 4T_1 + 4t_2 + 16t_3 = 24t,$$

or in other words, the sum of the number of tentacles equals 4 of the series first in the order of time, +4 of the second (or those next developed), +16 of the third. In two older stages of the *Tiaropsis*, the formulas are

$$\Sigma t = 4T_1 + 4t_2 + 16t_3 + 8t_4 + 8t_5 = 40t,$$

and

$$\Sigma t = 4T_1 + 4t_2 + 16t_3 + 8t_4 + 8t_5 + 16t_6 = 56t.$$

We refer to the paper for other examples of these important results.

In the second paper above mentioned, the author has illustrated, by many excellent figures, the reproduction by fission of some Annelids, and further has sustained the view, which has heretofore been questioned, that there is actual alternate generation in these species; showing that the individuals proceeding from the egg reproduce *only* by fission; and that from fission come males and females; and, from these males and females thus originating, reproduction by eggs again commences. A new American species of *Autolytus* also is described, and its development from the egg described and illustrated.

VI. ASTRONOMY.

1. *On the double star μ Herculis*, (in a note to the Editors of this Journal, dated Cambridgeport, Feb. 20, 1863.)—In the summer of 1856, I discovered that the companion of μ Herculis was a double star, but having no suitably mounted instrument for executing measures of either position or distance, I reported the case to Mr. Bond at Cambridge, and also to Mr. Dawes of England.

The latter has published the following measures, made soon after its discovery, in the Monthly Notices of the Royal Astronomical Society of London, vol. xvii, No. 9. $P = 58°{\cdot}97$; $D = 1''{\cdot}85 \pm$.

In July, 1862, I found $P = 70°$; the distance remaining about the same, or certainly not increased. Mr. Dawes calls them $10\frac{1}{2}$ and 11 magnitudes. Considering the large distance and minuteness of the components, this change in the angle of position is very remarkable.

Another interesting object, at this time, is ζ Herculis; so nearly in conjunction, the past summer, that it could not be divided with a fine eight inch glass, in the best atmosphere, with a power of 1000. A notable epoch in its history! ALVAN CLARK.

2. ALVAN CLARK *receives the LaLande Prize.*—The LaLande Prize of a gold medal, value 500 francs, has been awarded by the French Academy of Sciences in January last to Alvan Clark of Cambridgeport, for his discovery of the companion of Sirius (*this Journal*, xxxiii, p. 286). It will be noticed that the great $18\frac{1}{2}$ inch objective with which Mr. Clark made this remarkable observation, has been purchased by the Chicago Astronomical Association.

3. *The Astronomical Association of Chicago.*—This new association have purchased the great $18\frac{1}{2}$ inch object glass made by ALVAN CLARK of Cambridgeport, Mass., for the University of Mississippi under the order of President Barnard. The price paid was $11,187, the same sum Mississippi was to have paid for it. It will cost about an equal sum to mount it properly.

We congratulate the prosperous city of Illinois on the possession of this remarkable objective, which already, while mounted only in a rude tube of wood, has won for its talented maker the LaLande medal.

The possession of such an instrument implies a well organized Observatory, with all its appointments, for the endowment of which Chicago lacks neither the spirit nor the means.

4. *Shooting Stars of Dec. 10th–13th*, 1862.—Mr. BENJAMIN V. MARSH writes from Philadelphia, that on the evening of the 10th of December, between $10\frac{1}{2}^h$ and 11^h, he noticed about half a dozen brilliant meteors. They radiated from the vicinity of Castor and Pollux. The next morning, during the half hour, 4^h to $4\frac{1}{2}^h$, they were not remarkable for number or brilliancy, but all radiated from the same vicinity.

On the morning of the 12th, Prof. Gummere and Mr. Battey saw at Haverford, Pa., 28 in $1\frac{1}{4}$ hours, nearly all of which radiated from a point about midway between Castor and Pollux.

Mr. Marsh adds, "the report which Mr. George Wood made on the 11th Dec., 1861, (*this Journal*, xxxiii, p. 149,) would agree very well with this radiant, so that I think there is strong reason to conclude that from the 10th to the 12th of December the meteors mostly belong to *one* group radiating from the vicinity of Castor and Pollux. Is it not probable that on most occasions the great body of those seen belong to a regular group reappearing annually, and that such groups, variously scattered through the year, and sometimes perhaps over-lapping, make up the mass of the meteors seen?"

VII. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Scientific application of the Metric System of Weights and Measures.*—The establishment of the International Decimal Association in the year 1855, has at length resulted in the appointment of a Committee of inquiry by the British House of Commons, which after examining numerous witnesses of great eminence, has presented to Parliament a report recommending the adoption, throughout the British Empire and for all purposes, of the Weights and Measures of the Metric System. This report, having been published by the House of Commons, with the evidence of 39 witnesses and an analytical index, forms a "blue book" of nearly 300 pages. Besides matters of the utmost importance in regard to the improvement of education, the progress of domestic trade and of foreign commerce, and the advance of the general interests of humanity, it merits the attention of all who are engaged in scientific pursuits on account of its statements in regard to the progress of the Metric System among chemists, physiologists, and other philosophers. The witnesses, whose testimony relates to this subject, are, Thomas Graham, F.R.S., Master of the Mint; Professor Miller, of Cambridge, one of the Commissioners appointed by the British Government to restore the lost standards of weights and measures; T. L. Donaldson, Professor of Architecture in University College, London, and a Juror of the International Exhibition; Dr. Bolley, Director of the Polytechnic School and Professor of Applied Chemistry at Zurich. The testimony of these gentlemen is to the following effect:—

Within the last ten years the Metric System has made great progress in the British Islands so that it is used almost exclusively in chemical pursuits. It now forms a sort of common scientific language understood everywhere. Papers published in England with the national weights and measures are neglected on the continent, being so far unintelligible. Scientific men generally look forward to the universal adoption of this system, being of opinion that no other can prevail. It begins to find a

place in elementary English books. It is used in papers read before the Royal Society. On the other hand, the English weights and measures are so complicated that it is impossible to use them, and some of them, such as the scruple and the drachm, are little known even by name. The grain has been decimally divided for more than 30 years, and Mr. Oertling of London now makes delicate balances with grain weights, which are commonly used by chemists and at the colleges. As far as scientific investigations are concerned, the old English method is entirely useless. In our scientific journals, weights are almost universally given in grams, and lengths in millimetres. In Switzerland, as well as in other continental nations, the Metric System is the only one in use for scientific purposes: without its adoption they cannot write on chemical or physical matters. In Alexandria the builders all use the metric form employed by the French and Italians, extreme difficulty and confusion being produced in architecture and engineering by the diversity of weights and measures. At the late International Exhibition in London the foreign jurors abandoned in despair the task of drawing parallels between the values of British and foreign goods.

The claims of science, to have the benefit of the Metric System, have likewise been represented at an interview, on the 18th of November, with the Rt. Honorable Milner Gibson, M.P., President of the Board of Trade. On this occasion, Professor Owen of the British Museum showed the value of the system in the study of natural history. The majority of the facts in this science include the elements of weight and measure. But, besides the confinement to Britain of its own national weights and measures, which constitute a wall of separation between British and foreign science, innumerable mistakes arise from their variety, their intricacy, and their want of system. Uncertainty arises between avoirdupois and troy, and between divisions of the inch into tenths and twelfths, both of which are called "lines."

In the United States and the South American States, the employment of the Metrical System for scientific purposes is all but universal, and, in those institutions of learning where this system is employed by teachers, the results are always most satisfactory.

2. *Pasteur* has been chosen and confirmed a member of the French Academy, in the section of Mineralogy, in place of De Sénarmont, deceased. Des Cloizeaux was his competitor (*ex æquo*), in the second rank Delesse, and in the third Hébert. The vote stood thus: 69 votes, 31 requisite for a majority, the first ballot gave Pasteur 36, Des Cloizeaux 21, and Delesse 3.—*Session of Dec.* 8, 1862.

VIII. BOOK NOTICES.

1. *Storer's Dictionary of Solubilities of Chemical Substances.*[1]—Mr. Storer here presents us the first installment of a work on which he has been long engaged with well known assiduity, and which is destined to connect his name inseparably with chemical literature. This part of the *First Outlines* takes us nearly to the close of the letter C, probably a near approach to one third the bulk of the entire work. The term

[1] First Outlines of a Dictionary of the Solubilities of Chemical Substances. By Frank H. Storer. One volume in three parts. Part I, 8vo, pp. 232. Cambridge: Sever & Francis, 1863. B. Westermann & Co., New York.

solubility is used by Mr. Storer in its most comprehensive sense, thus grouping by this character a wider range of phenomena than might at first appear germane to this single constant. Thus the plan includes, not only "the comportment of a substance towards water, alcohol, wood spirit, ether, oil of turpentine, benzine and analogous hydrocarbons, and the other neutral solvents;" but also in many cases observations on the action of acids and alkalies, as well as the influence of one salt on the solubility of another.

The alphabetical arrangement makes the work one of extreme convenience for reference, as it proceeds on no principle of selection, but gives the names of all substances, each in its proper place, with formulas of constitution, and in all important—we might almost say in all possible—cases, with references to original memoirs or authorities. The arrangement of substances is by the acids rather than by the bases. Thus the acetates, chlorhydrates, chlorids, carbonates, &c., are made to embrace all the salts of these electronegative substances. It of course falls into the plan of this work to present full tables of solubilities of all the important substances of common use in the laboratory, as ammonia, chlorhydric acid, various chlorids, carbonic acid, carbonates, alcohol, acetic acid, the acetates, &c. &c. The qualities of accuracy, fullness, convenience of reference and quotation of authorities will secure the use of this Dictionary of Solubilities, not only by all investigators, but no analytical student who has well mastered his Fresenius can afford to be without it, while manufacturers and pharmaceutists will find it the most convenient *vade mecum* at their command.

Mr. Storer tells us in his preface that he was driven, after some six years of labor, to the expedient of printing, in order to facilitate the completion of the projected work, owing to the great bulk and increasing complexity of the manuscript, with its innumerable interpolations. The present work is therefore, as its title indicates, in many points only a general outline requiring innumerable details to fill up each special feature. But taken as it stands it is a monument of amazing labor, erudition, and skillful authorship. Such "compilations" can be made only by the hand of a master. Mr. Storer has for some time been recognized as one of our most encyclopedic chemical scholars. The readers of this Journal need no other reference than to the very numerous contributions which have lately appeared from his pen in our pages, on a great variety of subjects. The article on coal oils, published in the modest form of a review of Dr. Antisell's book, has been very widely reproduced, and is highly complimented by Wagner in the *Jahresbericht*, while his papers on the alloys of copper and zinc and on the impurities of zinc (the latter in company with Eliot) have become the authority on those subjects at home and abroad, being quoted by Kerl, Otto, Percy and others. Storer has from the commencement of the *Repertoire de Chemie* been selected as the American Editor of that well known Journal.

We are assured of the early completion of the *First Outlines*, and we cannot wish any author a longer life or more sustained and useful labor than is implied in the completion of the work in all its details according to the original plan.

2. *New American Cyclopedia*, vols. XV and XVI.—This work, which has been nearly six years in hand, is completed. Some of the articles in

vol. xv which are of most scientific interest are Steam and Steam engine, Steel, Sugar, Symbols, Telegraph, Telescope, Thermometer, Tides, Tobacco, &c. The most elaborate article in this volume is very naturally *United States*, which fills 122 pages, and contains a vast amount of valuable matter in a compact form.

In volume xvi we notice the following titles of scientific interest: Volcano, Warming and Ventilation, Weights and Measures, Walrus, Whale, Wheat fly and Moth, Winds, Zeuglodon, Zinc, Zoology, and many more. A list of contributors, with the titles of their articles, is given in vol. xvi. Among them we find very many of our best authors in all departments. A mere enumeration of the principal ones would exceed our present limits. One of the daily journals gives some statistics of this great literary enterprise, from which we borrow a few items:[1]

The present work of Messrs. G. Ripley and C. A. Dana is the first original general Cyclopedia completed in this country. Dr. Lieber's valuable translation of the German *Conversations-Lexicon*, made many years ago by that industrious and erudite scholar, with the assistance of a staff of writers, was long a standard work, but the rapid march of modern events has left it behind; and no attempt was ever made, we believe, (beyond the issue of one supplementary volume, the xivth,) to bring up arrears in monthly supplements like those printed by Messrs. Brockhaus in Germany, as continuations of the last edition of the *Conversations-Lexicon*.

Since 1857, besides the two editors already named, a staff of twenty-five writers has been occupied upon the American Cyclopedia in a large office provided with an ample reference library in various languages, aided also by the Astor Library. Numerous gentlemen outside the regular corps have also contributed articles on subjects upon which they were specially conversant.

The labor of revising the articles as written, and again revising the proof sheets, employed not only the two editors, but in addition five or six other gentlemen, especially competent for this work, who verified dates and other figures, and so far as is possible to human handiwork, made each page perfect. Besides this, proofs of all the more important articles were sent to the authors, or to experts, for verification and correction. The cost of the revision alone amounts to considerably over twenty thousand dollars.

The number of titles or subjects treated is about twenty-seven thousand in 13,804 pages, of 52 million "ems" printers measure, requiring, for 10,000 copies printed, over 12,600 reams of white paper. Before the rebellion, over 17,000 subscribers to the work were registered, of which about 5000 were in disloyal states.

Messrs. Appleton, the enterprising publishers, have invested over four hundred and fifteen thousand dollars in this great literary venture, of which $143,700 went to contributors and for making the stereotype plates. The whole number of volumes printed is 227,550.

Of the literary execution of the work we can speak with satisfaction. Its scientific articles are in general far from possessing the completeness and finish which are to be found in the elaborate treatises (for such they in reality are) which are to be found in the Encyc. Britannica; but for the

[1] New York Evening Post.

purpose intended in their compilation, as a general and popular reference, they are quite sufficient in most cases, and often perfectly satisfactory. The work as a whole is full of information, accurate, and well arranged for reference. In any condition of affairs it would be a creditable production, but continued to a successful end amidst a great civil strife, it is peculiarly creditable to all concerned.

We understand that the design is to issue a supplementary volume which will bring the work up to the present times, to be followed hereafter by the issue of an annual volume, entitled

The American Annual Cyclopedia and Register of Progress and Events, the 1st volume of which, for 1861, has been on our table for some months, and that for 1862 will be soon issued in a style identical with the American Cyclopedia.

OBITUARY.

We have to record the death of several men of science since our last.

1. James Renwick, long Professor of Physics in Columbia College, New York, died in that city about the close of January, aged 78 years. Prof. Renwick's "treatise on the Steam Engine" was long an authority for engineers, and his Outlines of Natural Philosophy (2 vols. 8vo, Philadelphia, 1832) was the earliest extended treatise on physics by an American. For many years Prof. Renwick had retired from active service, enjoying with dignity an ample fortune.

2. Melins C. Leavenworth.—Dr. Leavenworth died near New Orleans, La., in December, while acting as Surgeon to the 12th Connecticut regiment. He was among the oldest of American botanists, his first paper, "on four new plants from Alabama," having appeared in vol. vii, of the first series of this Journal, in 1824. Dr. Leavenworth has resided, since his retirement from the medical service of the United States army, in Waterbury, Conn., until at the call for volunteers, well advanced in years and by no means firm in health, he went cheerfully to offer his life a sacrifice for his country.

3. Dr. Asahel Clapp, a botanist and naturalist, died at an advanced age, Dec. 17, 1862, at his residence, New Albany, Indiana. He was well known to collectors in botany and geology. His chief publication is a Report to the American Medical Association on the plants of the United States useful in medicine.

IX. WORKS RECEIVED.

Mathematics and Physics.—

Report of the Thirty-First Meeting of the British Association for the Advancement of Science; held at Manchester in September, 1861. London: J. Murray. 1862. 8vo, pp. 340 and 320.

An Elementary Treatise on Plane and Spherical Trigonometry, with their application to Navigation, Surveying, Heights and Distances, Spherical Astronomy, etc.; by Benjamin Peirce, LL.D., &c. Revised edition. Boston and Cambridge: James Munroe & Co. 1861. 8vo, pp. 327.

De la Théorie Mathématique de la Musique; par Alexandre-P. Prevost. Genève, 1862.

On the Density of Steam; by W. J. Macquorn Rankine, C.E., LL.D., F.R.SS. Lond. and Edin., &c. From the Trans. Roy. Soc. Edinburgh, 1852. 4to.

Vis Inertiæ Victa, or Fallacies affecting Science: an Essay to increasing our knowledge of some physical laws, and a Review of certain Mathematical Principles of Natural Philosophy; by James Reddie. London, 1862.

On Certain Forms of Interpolation; by W. P. G. Bartlett, A.M. Cambridge, 1862. Mem. Amer. Acad.

ASTRONOMY AND METEOROLOGY.—

Smithsonian Contributions to Knowledge.—Discussion of the Magnetic and Meteorological Observations made at the Girard College Observatory, Philadelphia, in 1841—1845. Part II. Investigation of the Solar Diurnal Variation in the Magnetic Declination, and its Annual Inequality; by A. D. BACHE, LL.D. Washington, June, 1862.

The same. Part III. Investigation of the Influence of the Moon on the Magnetic Declination; by A. D. BACHE, LL.D. Washington, June, 1862.

On Meteorology; by Prof. JOSEPH LOVERING, of Harvard University. Continued from the American Almanac for 1862.

Contributions to Meteorology for the year 1861, from observations taken at Isle Jesus, Canada East; by CHARLES SMALLWOOD, M.D, LL.D., Professor of Meteorology in the University of McGill College, Montreal.

Intorno alla Corrispondenza che passa tra i Fenomeni Meteorologici e le variazioni d'intensita' del Magnetismo Terrestre; memoria del P. ANGELO SECCHI.

Sul Recenti Progressi della Meteorologia. Discorso letto alla Pontificia Accademia Tibernia; dal P. ANGELO SECCHI, d. C. d. G., Direttore dell'Osservatorio del Collegio Romano; il giorno 8 Aprile 1861. Roma, 1861.

Report of the Regents of the University of the State of New York, on the longitudes of the Dudley Observatory, the Hamilton College Observatory, the City of Buffalo, the City of Syracuse. Albany, 1862.

Further researches on the Auroræ Boreales, and the phenomena which attend them; by A. DE LA RIVE. From the Phil. Mag. (Suppl.) for June 1862.

On the Lunar-Diurnal Variation of the Magnetic Declination, obtained from the Kew Photograms in the years 1858, 1859, and 1860; By Major-general EDWARD SABINE, R A , Treas. and V.P.R S. From Proc. Roy. Soc., January 1861.

Standard Mean Right-ascensions and Circumpolar and Time Stars, prepared for the use of the U. S. Coast Survey; A. D. BACHE, Supt. Washington, 1862.

On the Physical Constitution of Comets; by OLINTHUS GREGORY DOWNES, F.R.A.S. London, 1860.

Considerations on the phenomena attending the Fall of Meteorites on the Earth; by W. HAIDINGER, For. Mem. R.S.L. & E., &c. From the Philosophical Magazine for November and December, 1861.

Das Meteoreisen von Sarepta; von dem w. M. W. HAIDINGER. Mit 2 Tafeln. Akad. der Wissenschaften vorgelegt in der Sitzung am 24 Juli 1862.

An attempt to account for the physical condition and the fall of Meteorites upon our Planet; by W. HAIDINGER, &c. From Brit. Assoc. Report, 1861.

CHEMISTRY AND AGRICULTURE.—

A Manual of Chemistry, Descriptive and Theoretical; by WILLIAM ODLING, M.B., F.R.S., &c. Part I. 8vo, pp. 380. London: Longman, Green, Longman & Roberts. 1861.

On Mauve and Magenta: a Lecture delivered in the theatre of the Royal Institution of Great Britain; by A. W. HOFMANN, Ph.D., LL.D., F.R.S., President of the Chemical Society. London: W. Clowes & Sons. 1862.

Preliminary Researches on Thallium; by WILLIAM CROOKES, Esq., F.C.S. 1862.

Remarks upon the Recent Determinations of the Atomic Weight of Antimony: by WILLIAM P. DEXTER. From the Proceed. Am. Acad. of Arts and Sciences for January 14, 1862. Cambridge, 1862.

Medico-legal contributions on Arsenic: containing Reports of a number of cases of Arsenical Poisoning, together with an account of the methods employed in their Chemical Examination; by CHARLES H. PORTER, M.D., Professor of Chemistry and Medical Jurisprudence, Albany Medical College, Albany, N. Y. Albany, 1862.

Experimental Researches into a New Excretory Function of the Liver; consisting in the removal of Cholesterine from the Blood, and its discharge from the body in the form of Stercorine (the Seroline of Boudet); by AUSTIN FLINT, Jr., M.D., Professor of Physiology and Microscopy in Bellevue Medical College, N. Y. Illustrated by three plates. From the American Journal of the Medical Sciences for October, 1862.

Sur les Relations d'Isomorphisme qui existent entre les Métaux du groupe de l'Azote; par M. J. NICKLÈS, Professeur, etc. Nancy, 1862.

Report on the Chemical Analysis of Grapes, submitted to Hon. Isaac Newton, Commissioner of Agriculture; by CHARLES M. WETHERILL, Ph.D., M.D., Chemist of the Department. Washington, 1862.

First and Second Reports of PHILIP T. TYSON, State Agricultural Chemist, to the House of Delegates of Maryland. Annapolis, 1860, 1862.

Salt manufacture of the Saginaw Valley, Michigan; A. WINCHELL.

The Salt Company of Onondaga. Syracuse, 1862.

Report on the Brines of Onondaga; by C. A. GOESSMANN, Dr. Ph. Made to the Salt Company of Onondaga, December, 1862.

Contributions to the knowledge of the nature of the Chinese Sugar cane (Sorghum saccharatum, W.). Albany, 1862. From Transactions N. Y. State Agricultural Society, 1861.

Circular from the Commissioner of Agriculture of the United States, on the Agricultural, Mineral, and Manufacturing Condition and Resources of the United States. Washington, 1862.

GEOLOGY AND MINERALOGY.—

Ideal Views of the Primitive World, in its Geological and Palæontological phases; by Dr. F. UNGER, of Vienna. Edited by SAMUEL HIGHLEY, F.G.S., F.C.S., &c. Illustrated by 17 photographic plates. London. 4to.

On the Mode of Formation of some of the River-valleys in the south of Ireland; by J. BEETE JUKES, Esq., &c. From the Quart. Journ. Geol. Soc. for Nov., 1862.

Geological Survey of Canada.—Descriptive Catalogue of a collection of the Economic Minerals of Canada, and of its Crystalline Rocks, sent to the London International Exhibition for 1862. Montreal: John Lovell.

Notice of some new and imperfectly known Fossils from the Primordial Zone (Potsdam Sandstone and Calciferous Sand Group) of Wisconsin and Missouri; by B. F. SHUMARD, M.D. May, 1862. From the Trans. St. Louis Acad. Sci.

Description of new species of Fossils from the Devonian and Carboniferous Rocks of the Mississippi Valley; by CHARLES A. WHITE, of Burlington, Iowa. From the Proc. Boston Soc. Nat. Hist., Feb. 1862.

Descriptions of Fossils from the Marshall and Huron Groups of Michigan; by ALEXANDER WINCHELL. From the Proc. Philad. Acad. Nat. Sci., Sept., 1862.

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